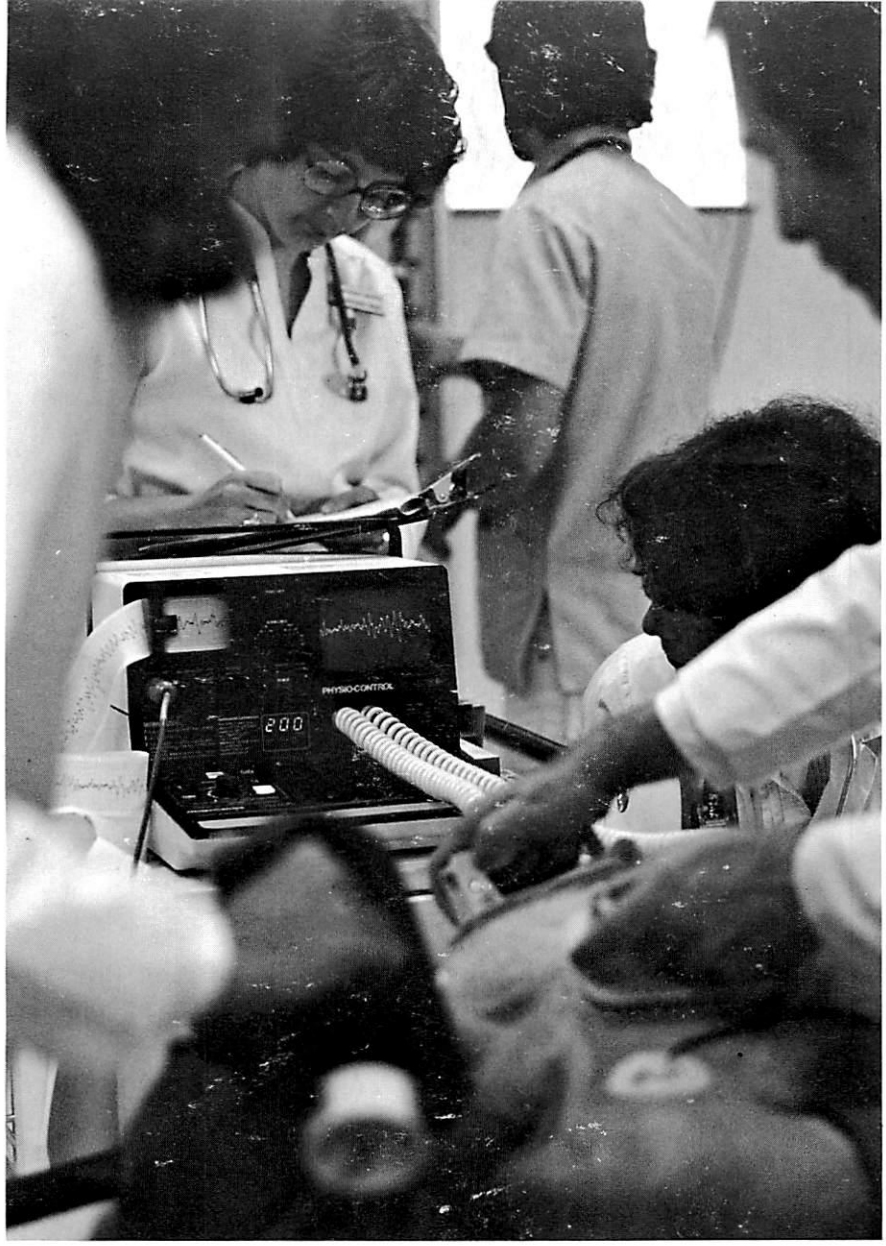

LIFEPAK® 6s

Cardiac Care System

Operating and Service Manual

Manual No. 801971-01
April 1983

PHYSIO CONTROL

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EQUIPMENT DASH NUMBERS COVERED IN THIS MANUAL

Monitor	801555-00 THROUGH 801555-11 801555-18 THROUGH 801555-69
Defibrillator	801585-00 THROUGH 801585-05 801585-09 THROUGH 801585-15

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HOW TO USE THIS MANUAL.

Section I of the manual provides introductory information with FUNCTIONAL DESCRIPTIONS and GENERAL SPECIFICATIONS.

Section II informs the authorized user how to OPERATE THE EQUIPMENT, identifies various CONTROLS AND INDICATORS, and gives simple SERVICING INSTRUCTIONS.

Section III gives detailed TECHNICAL OPERATION and circuit descriptions, accompanied by schematic drawings, helpful in understanding the high-technology electronic designs.

Section IV consists of MAINTENANCE PROCEDURES and test data which assist in TROUBLESHOOTING the equipment. DISASSEMBLY PROCEDURES are also described.

Section V contains ILLUSTRATED PARTS LISTS with EXPLODED VIEWS to help identify replaceable parts by number and location.

Section VI is a folio of useful SCHEMATIC DRAWINGS which are updated periodically, as well as useful connector pin-outs and interconnect information. We believe this compendium of information will be helpful to maintenance staff, and others.

SECTION 1
INTRODUCTION

1-1. SCOPE

The manual provides the operating and service procedures for the LIFEPAK 6s ECG Monitor and DC Defibrillator units manufactured by Physio-Control Corporation, Redmond, Washington.

The six sections of this manual provide the Introduction, Functional Descriptions and Specifications, Operation, Circuit Descriptions, Maintenance Procedures, Illustrated Parts Lists, and Electrical Schematics.

1-2. PHYSICAL DESCRIPTION

The following paragraphs provide a brief physical description of the ECG Monitor and DC Defibrillator units.

Figure 1-1 shows the LIFEPAK 6s ECG Monitor unit and the DC Defibrillator unit. Table 1-1 lists the general specifications of LIFEPAK 6s System.

1-3. General. LIFEPAK 6s is a portable precision electronic cardiac care system for monitoring the ECG signal and for applying a controlled monophasic direct current (dc) defibrillating pulse to the heart. In the synchronized mode it may be used for performance of elective cardioversion by using the "R" wave as a timing reference.

The LIFEPAK 6s System consists of two units: An ECG Monitor unit and a DC Defibrillator unit ("DC", in this case, refers to the output pulse of the paddles, not the operating power requirement). Each unit is operable on AC line power or internal battery power. They may be operated independently of each other or together as a system. Internal batteries are charged when the units are connected to AC line power. Full battery charge is accomplished in 16 hours.

The ECG Monitor unit is connected to the Defibrillator unit by means of a slide connector. They may be separated by pressing the lock release button on the right side of the Defibrillator unit. When joined, the two units provide a lightweight system that can be used on a crash cart or hand carried.

The circuits used in the LIFEPAK 6s System are solid state, temperature stable and highly reliable. The instrument is suitable for use in a hospital environment. Use in a potentially explosive atmosphere is not recommended.

FIGURE 1-1. LIFEPAK 6s

CAUTION

- This instrument is to be used by authorized personnel only.
- The operator should be thoroughly familiar with information covered in Sections 1 and 2 of the service manual before using.
- The LIFEPAK 6s System should not be used in the presence of flammable agents or anesthetics.
- Do not discharge with the paddles short circuited together or in open air. Stay clear of patient when defibrillating.

1-4. ECG Monitor Unit. The ECG Monitor provides a continuous display on a non-fade Cathode Ray Tube (CRT) for monitoring and/or on an optional ECG Recorder. The recorder provides a hard copy of the information displayed on the ECG Monitor. The ECG Monitor unit also displays the heart rate from signals detected through Quik-Look Paddles, Internal Paddles, or through externally applied electrodes and a patient cable.

1-5. DC Defibrillator Unit. The Defibrillator delivers a controlled monophasic dc defibrillating pulse to the patient's heart with a delivered energy content of 5 to 360 joules (optional 400 joules). The pulse may be delivered with the paddles provided with the unit as well as with pediatric, anterior-posterior or through the limited energy, spoon shaped internal paddles. The Defibrillator also provides a display of energy available and delivered in the defibrillating pulse.

1-6. FEATURES AND FUNCTIONAL DESCRIPTION

The following paragraphs provide a functional description of the ECG Monitor and DC Defibrillator units.

1-7. ECG Monitor Unit. All controls are clearly labelled and easily accessible. The location and function of all controls are described and illustrated in Section 2. The patient-generated ECG waveform is displayed on either the ECG Monitor CRT and/or the Recorder which are driven by electrical networks designed for fast recovery from external overloading signals such as are experienced in defibrillation. The CRT Monitor trace sweeps at 25mm/sec. The Recorder provides real time diagnostic documentation at 25mm/sec. By selecting the DELAY position of the RECORDER switch on the control panel, the Recorder documentation is delayed by about 5 seconds from real time. In effect, this provides you with a 5-second memory which can be used to document a particular event. The circuits are shielded to reject radio frequency interference.

When monitoring a patient's ECG waveform through the patient cable, the input is protected from high voltage levels that may be present in the Defibrillator. A systole tone "beeper" with adjustable volume control is provided for audible monitoring when the ECG Monitor or Recorder cannot be watched.

The 3-digit heart rate display provides a continuous display of beats-per-minute (BPM) from 20 to 300 BPM. Adjustable low and high rate alarms are provided. If the pre-set limits are exceeded, an audio alarm system is triggered; the recorder may also be started automatically when an alarm occurs. The following additional features are included in the ECG Monitor unit: a one volt-per-millivolt (1V/mV) and a one millivolt-per-millivolt (1mV/mV) signal (real time) is available at the ECG OUT jack located on the back panel; a 1mV calibration output switch which provides a simulated test signal (set by pushing the QRS VOL switch); a battery condition indicator; a momentary FREEZE switch for freezing the ECG signal on the ECG Monitor CRT and a "battery charging" indicator.

1-8. DC Defibrillator Unit. The location and use of all controls for the Defibrillator are described and illustrated in Section 2.

Features of the Defibrillator are as follows:

A. Charge Indicator.
A Charge Indicator (signal lamp) flashes while the Defibrillator is charging. The indicator glows steadily when the unit is ready to deliver energy, and goes out when the energy is transferred to the patient, or discharged into a test load.

B. Deliverable Energy Display.
There is a Deliverable Energy Display which shows the amount of energy stored by the charge system. As the charge increases, the updating of the display is synchronized with the flashing of the Charge Indicator. The Deliverable Energy Display is a digital (LED) display which lets the user see the available energy level from a convenient viewing position. An illuminated legend, AVAILABLE ENERGY, indicates when the selected charge is ready.

C. Test Load Energy Display.
The same digital (LED) display is used to indicate the energy delivered into a test load. This feature is used to check the accuracy of the defibrillator energy output. An illuminated legend, TEST LOAD, indicates energy is being measured.

D. Battery Level Indicator.
The Defibrillator Unit is also equipped with a Battery Level Indicator to show the condition of the internal battery.

E. Energy Changing Features.
The Defibrillator Unit uses a charge storage capacitor to obtain a high voltage energy pulse. When the appropriate discharge buttons are pressed, transfer relays disconnect the capacitor from the charging circuits. The resulting energy pulse is discharged through the patient's chest by means of paddles which make contact with the patient, but are insulated from the operator.

The paddles supplied with the Defibrillator Unit are of the Quik-Look pattern (so-called because they may be used to pick up and

monitor the ECG signal from the patient). The unit is also compatible with internal paddles, and will accept clip-on pediatric paddles.

The energy available from the Defibrillator can be selected in ten fixed values within the range 5 to 360 joules. The instrument can be charged to 360 joules in ten seconds or less. A special option is available to deliver 400 joules.

F. Synchronized Cardioversion. This feature uses the patient's monitored ECG signal ("R" wave) to trigger the Defibrillator discharge. The Lifepak 6s Monitor unit must be connected to the Lifepak 6s Defibrillator Unit to use this feature. The synchronized discharge is used to correct atrial fibrillation, atrial flutter or other arrhythmias. Figure 1-2 shows how, by using the "R" wave as the triggering signal, the defibrillating energy pulse is delivered at the proper time. This avoids the undesirable T-wave portion of the ECG signal where electrical shock may cause ventricular fibrillation.

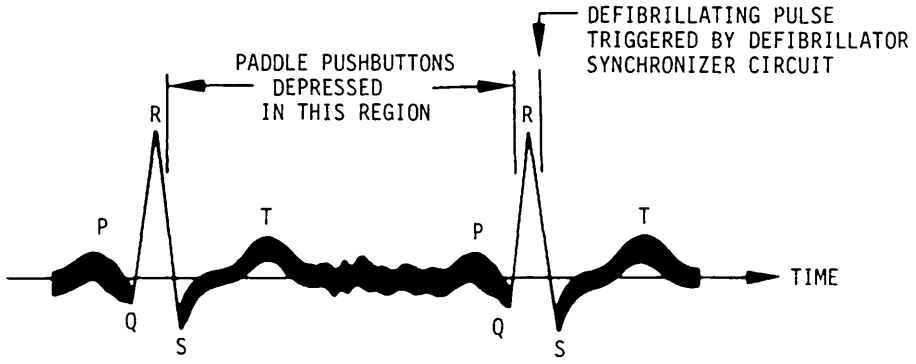


FIGURE 1-2. TYPICAL ECG WAVEFORM

TABLE 1-1

LIFEPAK 6s GENERAL SPECIFICATIONS

CHARACTERISTIC	*QUANTITY OR SPECIFICATIONS
ECG MONITOR UNIT • SIZE (envelope)	10.75"x12"x4.5" (27.3x30.5x11.4cm).
• WEIGHT	15 pounds (6.8kg).
• ECG MONITOR DISPLAY (CRT) Sweep Speed Bandwidth (-3dB)	3 inch x 4 inch (7.62cmx10.16cm). 25mm/sec. ±1mm. 0.5Hz to 30Hz.
• COMMON MODE REJECTION	65dB minimum with respect to isolated ground.
• BATTERY STATE INDICATOR	Indicates the condition of the battery.
• CALIBRATION	Test signal simulates 1mV input at the patient connector. Pushbutton switch to calibrate instrument.
• RATE METER (Heart Rate)	3-digit readout provides for display of the "R" wave rate from 20 to 300 (BPM).
• HEART RATE ALARMS	Both high & low heart rate alarm limits are adjustable. Low alarm range: 20 to 100 BPM, in steps of 10 BPM. High alarm range: 80 to 240 BPM in steps of 20 BPM. An audible alarm sounds if the set point limits are exceeded.
• ECG OUTPUT	1V/mV and 1mV/mV; 0.05Hz to 100Hz.
• INPUT	1) Obtained through a 3-lead, 4-lead or 5-lead cable, or through Paddles. 2) Selectable by rotary switch in any one of nine standard configurations (Paddles, I, II, III, AVR, AVL, AVF, V, STD). 3) Can perform 12-lead ECG Monitor.
• QRS VOL	Adjustable Volume for Systole beeper.

*Specifications subject to change without notice.

TABLE 1-1 (Continued)

LIFEPAK 6s GENERAL SPECIFICATIONS

CHARACTERISTIC	*QUANTITY OR SPECIFICATIONS
ECG MONITOR UNIT	
• ECG SIZE	ECG SIZE control with x 1 gain at fully counter-clockwise position.
• BATTERY CHARGING INDICATOR	Illuminates when the battery is charging. Full battery charge is accomplished in 16 hours for depleted cells.
• POWER SOURCE	
Battery Type	Nickel-Cadmium Battery, 14.4V 1.5AH.
Battery Capacity	ECG Monitor monitoring, 2.5 hours minimum at 25°C. Recorder monitoring, 1 hour minimum at 25°C.
AC Input Power	105 VAC to 129 VAC, 60Hz, or 198 VAC to 242 VAC, 50Hz and 60Hz 225 VAC to 280 VAC, 50Hz
Power Consumption	30W during ECG Monitor monitoring. 45W while recording.
• RECORDER DISPLAY	Paper Size 50mm x 30m (100 ft.).
Sweep Speed	25mm/sec (fixed).
Bandwidth (3dB)	0.05 to 100Hz (diag mode). 0.5 to 40Hz (Delay mode).
• FREEZE SWITCH	Momentary pushbutton switch for freezing QRS complex observed on CRT.
• RECORDER SWITCH	Four-position rotary switch selects AUTO, DELAY, DIAG. and OFF. OFF resets the alarm-operated recording.

TABLE 1-1 (Continued)

LIFEPAK 6s GENERAL SPECIFICATIONS

CHARACTERISTIC	*QUANTITY OR SPECIFICATIONS
DEFIBRILLATOR UNIT • SIZE (envelope)	19.24x12x4.5 inches (48.9x30.5x11.4cm).
• WEIGHT	19.25 pounds (8.6kg).
• WAVEFORM	Monophasic Pulse, (Edmark).
• OUTPUT ENERGIES (Delivered-50 ohm load)	5,10,20,30,50,100,150,200,300,360 joules (optional 400 joules). Internal Paddles: 5,10,20,30,50 joules (Higher energies cannot be charged or delivered).
• CHARGE TIME	To 360 joules in 10 seconds or less.
• BATTERY STATE INDICATOR	Indicates charge condition of battery.
• OUTPUT PADDLES Electrode Size	82cm² (adult).
Cord Length	Extended Length 10 feet.
• BATTERY CHARGING INDICATOR	Illuminates when battery is charging. Full battery charge is accomplished in 16 hours for depleted cells.
• POWER SOURCE Battery Type	Nickel-Cadmium Battery, 12V/1 AH.
Battery Capacity AC Input Power	25 360-joule discharges minimum at 25°C. 105 VAC to 129 VAC, 60Hz, or 198 VAC to 242 VAC, 50Hz and 60Hz 225 VAC to 280 VAC, 50Hz.
Power Consumption	160W while charging the defibrillator storage capacitor. 15W while OFF (charging the batteries). 20W while ON in standby mode.

TABLE 1-1 (Continued)

LIFEPAK 6s GENERAL SPECIFICATIONS

CHARACTERISTIC	*QUANTITY OR SPECIFICATIONS
DEFIBRILLATOR UNIT	
• ENERGY SELECT	Ten position rotary switch for presetting the discharge energy.
• CHARGE CONTROLS	Pushbutton on front panel or paddle-mounted pushbutton (on APEX Paddle) initiates automatic charging to selected level.
• AVAILABLE ENERGY DISPLAY	3-digit (LED) display shows energy available into a typical 50 ohm thoracic load and energy delivered into a TEST LOAD.
• ISOLATED OUTPUT	Defibrillator output electrically isolated.
• DISCHARGE CONTROL (Applies Stored Charge)	Simultaneous depression of pushbuttons on both paddles discharges available energy. Pushbutton on control panel discharges stored energy through Internal Paddles, when used.
• DEFIBRILLATOR SYNCHRONIZER Synchronized defibrillating pulse for elective cardioversion timed to occur on the first patient-generated "R" wave which follows defibrillate command.	
Sync trigger indication	Bright spot Marker on CRT trace identifies sync trigger point.
Sensitivity Control	ECG SIZE control on Monitor acts as threshold control.
SYNC-Defib Mode Control	Pushbutton switch can be depressed to change mode instantly from non syncronized defibrillation to syncronized, elective cardioversion and visa-versa.

TABLE 1-1 (Continued)

LIFEPAK 6s GENERAL SPECIFICATIONS

CHARACTERISTIC	*QUANTITY OR SPECIFICATIONS
DEFIBRILLATOR UNIT GENERAL Line Cord	Each unit is provided with special ten foot, low leakage, low capacitance cable with special hospital grade 3-prong connector.
Switches	Separate ON-OFF switches are provided for ECG Monitor/Recorder and Defibrillator units.
ENVIRONMENTAL CONDITIONS Unless otherwise stated the performance requirements of LIFEPAK 6s shall be met under the following storage and operating conditions.	
• ATMOSPHERIC PRESSURE	500 to 775mmHg
• RELATIVE HUMIDITY	0 to 85% (non-condensing).
VIBRATION	MIL-STD-810C, Method 514.2, Procedure VIII, Figure 514.2-6, Curve V.
• SHOCK (capable of meeting operating requirements after shock).	30g's, 11 ±1ms, half-sine, 18 impact shocks (3 in each direction) along each of three mutually perpendicular axis.
• DROP TEST (without resulting in operator or patient hazard during drop).	1 1/2 foot drop (45.7cm) on a concrete floor on each axis (6 drops).
• TEMPERATURE RANGE	0°C to 45°C Operating. -30°C to +65°C Storage.

*Specifications subject to change without notice.

TABLE 2-3 (Continued)

DC DEFIBRILLATOR UNIT CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
8	BATT LEVEL	Battery Level indicator will display battery charge state constantly while power is on. Check the indicator with AC line cord disconnected from AC power outlet, and with POWER switch on: Marker in green zone indicates good battery; marker in red zone indicates low battery. A low battery can be fully charged in 16 hours by connecting AC line cord to a proper AC power outlet (grounded).
9	BATT CHG	Indicator will illuminate when battery is charging.
10	SYNC Pushbutton/Indicator	Switch (illuminated) to select synchronized mode. Switch light will flash with each QRS. To return to defibrillate (asynchronous) mode, depress button again. Defibrillator is automatically in defibrillate mode when unit is turned on and automatically returns to defibrillate mode after discharge or if unit is disconnected from ECG Monitor.
11	Discharge Pushbuttons	Discharge pushbuttons on both paddles must be depressed simultaneously to apply charge. Energy will not be delivered unless the available energy display indicates AVAILABLE ENERGY and the charge indicators are glowing steadily.

TABLE 2-3 (Continued)

DC DEFIBRILLATOR CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
12	TEST LOAD Indicator	Digital display of energy (joules) increments during charge showing progress of charge. Confirms selected energy attained at full charge. Also displays energy delivered into TEST LOAD (100 or 360J) for 4 seconds following discharge.
13	AVAILABLE ENERGY Display	Illuminates at full charge indicating energy displayed is available and will be discharged upon command.
14	TEST LOAD Display	Illuminates following discharge into TEST LOAD indicating energy displayed was delivered into TEST LOAD.
15	Test Load Contacts	50Ω Defibrillator test load. Metal contacts for receiving energy pulse from Paddles.

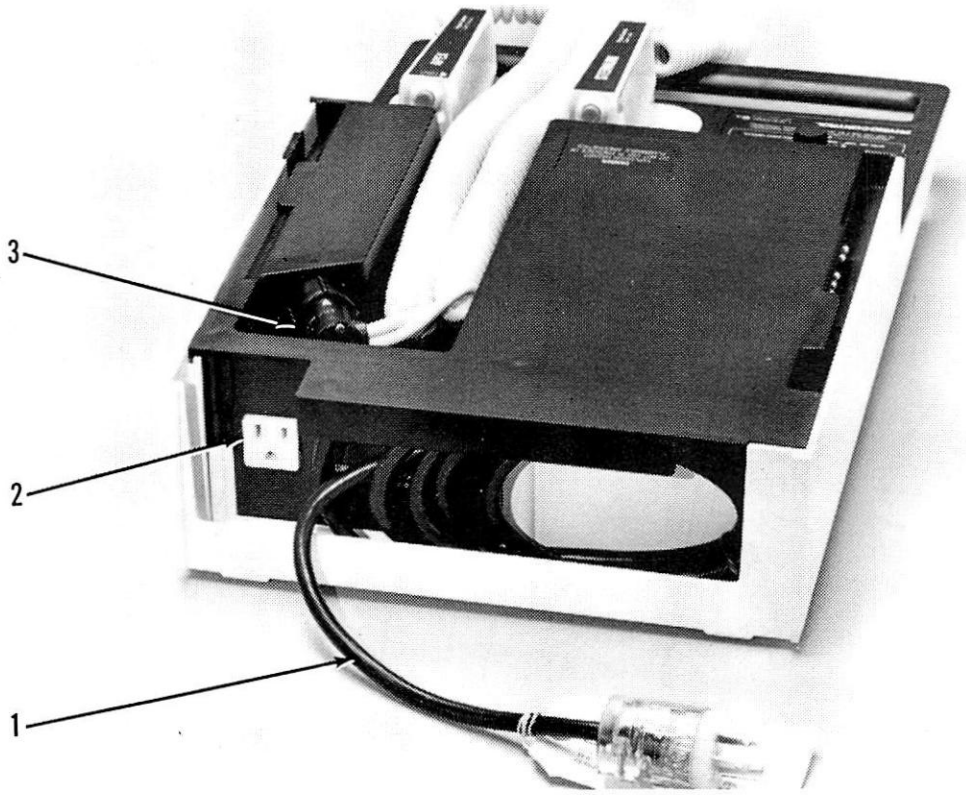


FIGURE 2-4A. DC DEFIBRILLATOR UNIT REAR PANEL

TABLE 2-4A

DC DEFIBRILLATOR UNIT REAR PANEL

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	AC Power Cord	Connects Defibrillator unit to AC power source receptacle.
2	Monitor Power Receptacle	Receptacle for ECG Monitor/ Recorder AC Power Cord (only) when the two units are used as a combined instrument.
3	Paddle Connector	Connector for external or internal paddles.

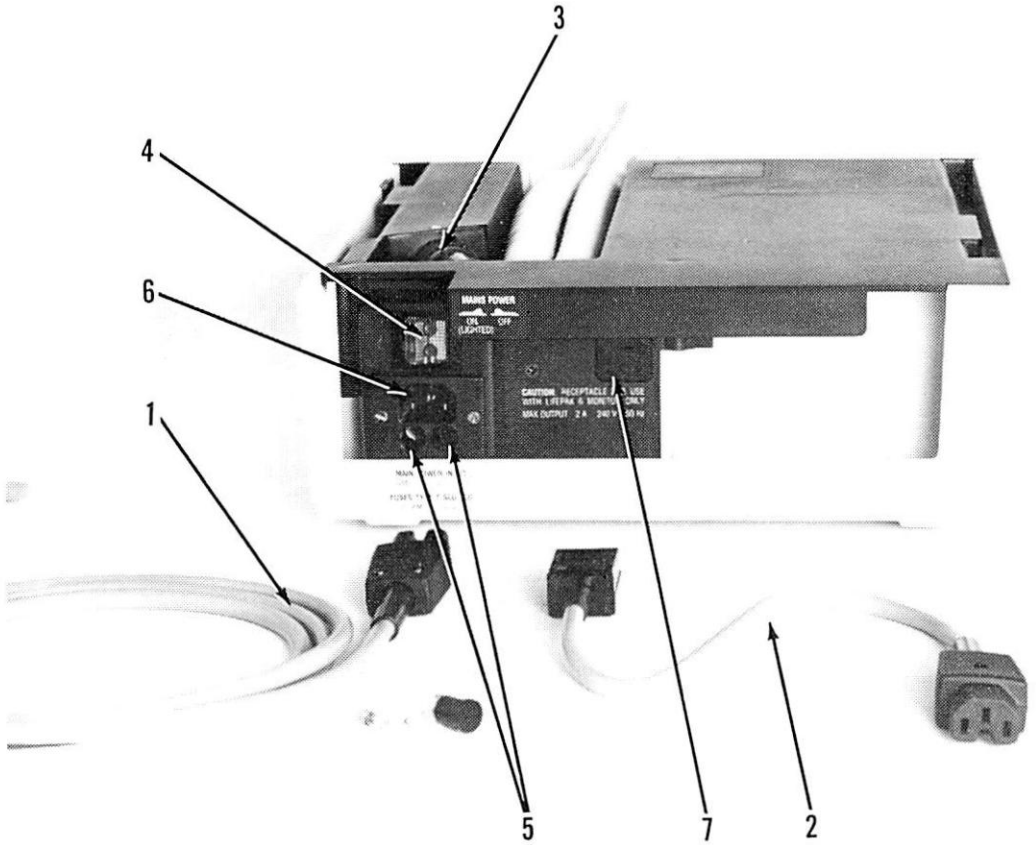


FIGURE 2-4B. DC DEFIBRILLATOR UNIT REAR PANEL

TABLE 2-4 B

DC DEFIBRILLATOR UNIT REAR PANEL

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	Mains Power Cord	Connects Defibrillator unit to Mains AC power source receptacle.
2	Interconnect Power Cable	Connects Main power from Defibrillator unit to ECG Monitor Unit when the Defibrillator is connected to Mains power.
3	Paddle Connector	Connector for external or internal paddles.
4	MAINS POWER Switch	On/Off switch for Mains power. Illuminates when on.

TABLE 2-4 B (Continued)

DC DEFIBRILLATOR UNIT REAR PANEL

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
5	Mains FUSES	Mains voltage/current surge protection.
6	MAINS POWER Input Receptacle	Mains Power Cord plugs in here.
7	Interconnect Power Receptacle	Interconnect Cable plugs in here.

2-3. OPERATING INSTRUCTIONS

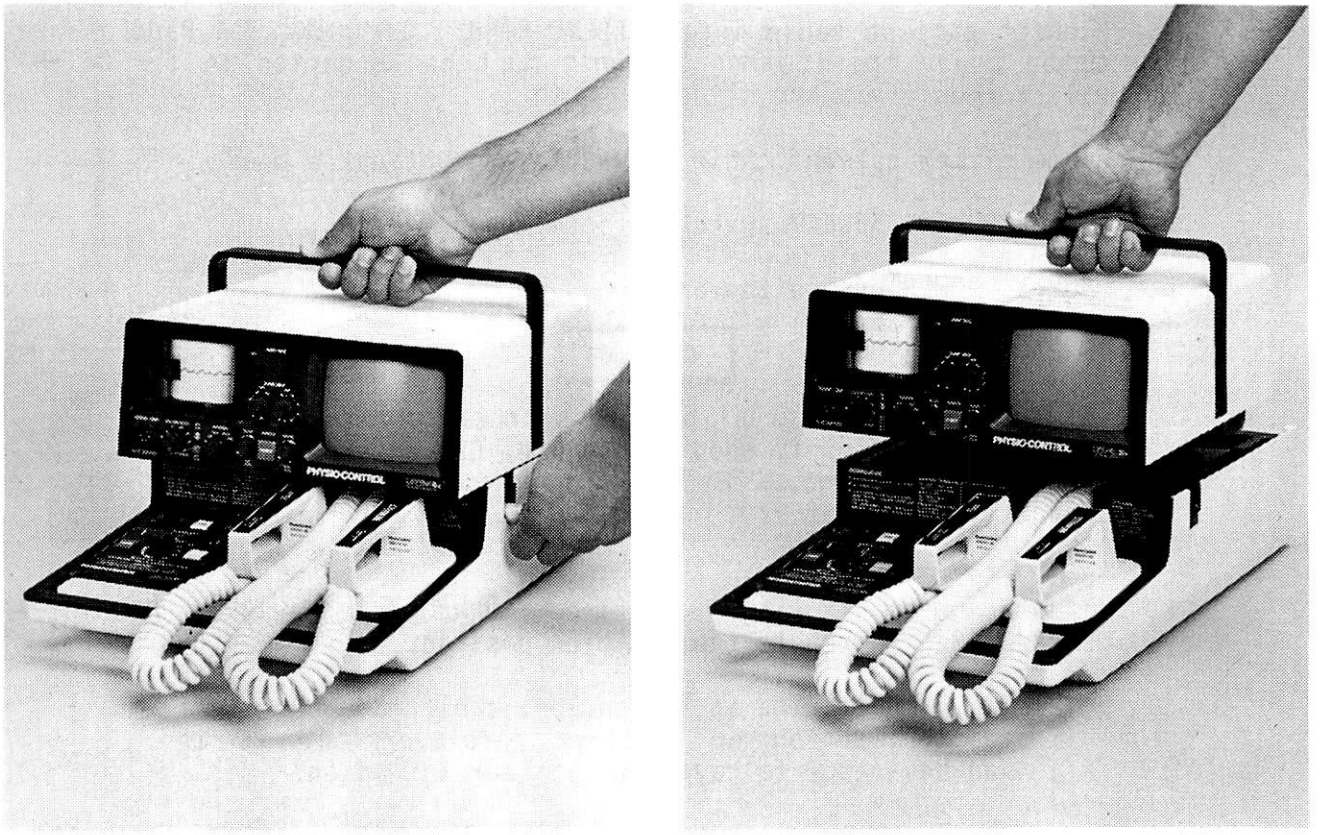
The following paragraphs provide brief operating instructions for the LIFEPAK 6s cardiac care instrument. Observe the following precautions while operating the instrument.

WARNING

- This instrument is to be used by authorized personnel only.
- The operator should be thoroughly familiar with information covered in Sections 1 and 2 of this manual.
- The LIFEPAK 6s system should not be used in the presence of flammable agents or anesthetics.
- Do not discharge with paddles shorted together.
- Stay clear of patient when defibrillating.
- Do not discharge Defibrillator into open air.
- Keep defibrillator paddles clean. Paddles covered with gel (wet or dry) present a hazardous electrical pathway between paddle electrodes and the user during defibrillator discharge.
- Do not operate Defibrillator in the presence of strong high energy electrical fields such as those generated by diathermy. Always turn off diathermy equipment before using the Defibrillator.

2-4. Power Source, AC or dc Operation. To operate AC/dc instruments on AC line (mains) input power, connect AC or Mains Power Cord to the unit and to a proper line (mains) power source. DO NOT USE A FREE-GROUNDED ADAPTER. The ECG Monitor can use a mains power cord as described, or can use the Interconnect Power Cable as illustrated in Figure 2-4. Turn (MAINS) POWER switch on rear panel to ON (switch light illuminated). To operate instruments on internal battery (dc), turn (MAINS) POWER switch OFF and/or disconnect the (Mains) Power Cord from the wall outlet. Turn (MAINS) POWER switch ON and observe the BATT LEVEL indicator. Indicator should be in the "green" zone which indicates adequate battery voltage. When either instrument is connected to a proper AC source, the internal battery will charge. A depleted battery will recharge in approximately 16 hours.

NOTE: On some units the power cord is attached in the unit and does not have a rear panel power switch.



SLIDE CONNECTION SEPARATION

FIGURE 2-5. CONNECTING THE UNITS

2-5. Connection. As shown in Figure 2-5, the ECG Monitor unit is connected to the Defibrillator unit through a special slide connector. The slide connector makes both mechanical and electrical connections between the two units. This electrical contact is used to transfer the Quick-Look paddle pickup of the low level ECG signal from the Defibrillator to the ECG Monitor. In the synchronized mode, it transfers the trigger pulse from the ECG Monitor to the Defibrillator. AC line power or dc battery power is not transferred by the slide connector.

The units are separated by pressing the lock release button on the right side of the Defibrillator and pulling the ECG Monitor forward and up. When the units are separated, the electrical slide contacts are exposed. These exposed contacts do not represent a safety hazard and no dangerous voltages are ever present at these contacts.

2-6. ECG Monitor Unit. The following paragraphs provide brief operating instructions for LIFEPAK 6s ECG Monitor unit. Refer to Paragraph 2-9 for Operator Service which includes an operational checkout.

A. Connect patient cable into PATIENT CONN. If QUIK-LOOK Paddles are to be used, the ECG Monitor unit must be connected to the Defibrillator unit via the slide connector.

B. Place either patient cable or paddles on patient's chest.

C. Turn ECG LEAD SELECT switch to position desired.

D. Depress POWER pushbutton on.

CAUTION

After using the internal battery source, turn the instrument POWER switch off when not in use. Connect to AC power source to recharge. Failure to do so will drain the charge from the battery.

E. If Recorder monitoring is desired, adjust the Recorder OFF/AUTO/DELAY/DIAG. switch to the position desired.

NOTE: When monitoring in the patient cable mode, during a defibrillation or elective cardioversion, it is an advantage to have the recorder turned on.

F. Depress 1mV (PUSH) switch and adjust ECG SIZE control for a 10mm square wave display on Recorder or a suitable display on the monitor.

G. Adjust ECG SIZE control to obtain desired patient-generated ECG display on Monitor and Recorder or 1mv/cm if this recorder gain is desired.

H. Adjust QRS VOL control to the desired sound volume of the systole tone. When volume is adjusted, "beep" tone should coincide with each QRS complex waveform on the monitor display.

I. To obtain heart rate monitoring or for synchronized cardioversion increase the ECG size until the QRS display flashes in synchronism with the QRS waveform on the CRT. Advance the control 1/8 turn further.

J. If use of the ALARM LIMITS is desired, adjust the controls for proper HIGH and LOW limits.

NOTE: Audible alarm is continuous when preset alarm limits are exceeded. To turn off audible alarm, move the HIGH and/or LOW limit adjustments beyond the patient's rate or to OFF. If auto/record is desired, turn recorder switch to AUTO.

K. If desired, connect external monitoring equipment to the ECG OUTPUT jack.

WARNING

Do not connect accessory equipment to the ECG OUTPUT jack unless it has been evaluated for fire and shock hazard when used with LIFEPAK 6s.

L. To study the ECG signal on the ECG Monitor display, push and hold the FREEZE switch.

NOTE: If the FREEZE (PUSH) switch is depressed while recording in the DIAG mode, recording is uninterrupted. If the FREEZE (PUSH) switch is depressed while recording in the DELAY mode, recording reverts to real-time until the FREEZE switch is released. At that time, frozen information is recorded and the unit then returns to DELAY mode.

2-7. DC Defibrillator Unit. The following paragraphs provide brief operating instructions for DC Defibrillator. Monitoring with the paddles is discussed in Paragraph 2-6. Refer to Paragraph 2-9 for operator service including an operational checkout. ON THE FRONT PANEL THE NUMERALS ABOVE THE CONTROLS EMPHASIZE THE SEQUENCE OF OPERATION.

A. Apply conductive gel to paddle electrodes.

B. Depress POWER pushbutton (1) to turn on unit. Switch will illuminate.

NOTE: If operating on internal battery power, check BATT LEVEL indicator to insure adequate battery voltage. Indicator should be in green zone. Charge time may be excessive if battery level is low.

C. Select desired energy to be delivered with ENERGY SELECT switch (2).

D. Depress and release CHARGE pushbutton (3) either on Defibrillator front panel or on APEX Paddle.

WARNING

Automatic selection of maximum energy is not recommended (see Operators Instruction Manual).

E. Verify AVAILABLE ENERGY display indicates the value selected.

F. Place paddles firmly on patient's chest.

G. Defibrillator is ready to fire when amber CHARGE Indicators stop flashing and glow steadily and AVAILABLE ENERGY is displayed. Defibrillator will not fire unless fully charged to preset level.

NOTE: Once the Defibrillator has charged to the desired level and the CHARGE Indicators stop flashing, the instrument is ready to fire. If not fired within approximately 64 seconds, the charge indicator will go out and the unit must be recharged before using.

If the ENERGY SELECT switch (2) setting is changed while the Defibrillator is charged, the energy is automatically internally discharged. It is necessary to recharge the instrument to defibrillate at a different setting.

WARNING

Stay clear of patient when defibrillating.

H. Depress both paddle discharge pushbuttons simultaneously to defibrillate.

I. If repeat application of charge is necessary, select desired energy with ENERGY SELECT switch (2), depress CHARGE pushbutton (3) and repeat as above.

J. To dispose of unwanted charge or turn off Defibrillator, depress POWER pushbutton (1) on Defibrillator front panel. Switch light goes out.

K. For internal defibrillation the external paddles are disconnected from the instrument (the LIFEPAK 6s ECG Monitor unit must be separate from the Defibrillator unit to expose the Paddle connector) and the internal paddles are then connected.

1. To defibrillate, depress POWER pushbutton (1) Switch light will turn on.

2. Select energy to be delivered with ENERGY SELECT switch (2).

NOTE: Delivered energy is limited to 5, 10, 20, 30, and 50 joules with internal Paddles.

3. Depress and release CHARGE pushbutton (3) on front panel. Defibrillator is ready to fire when CHARGE Indicators stop flashing and glow steadily and AVAILABLE ENERGY is displayed.

4. Depress INTRNL PADDLE DISCHG switch on front panel to defibrillate.

5. If a repeat application of charge is necessary, select desired energy with ENERGY SELECT switch (2), depress CHARGE pushbutton (3) and repeat as above.

2-8. Synchronized Cardioversion. The following paragraphs provide brief operating instructions for LIFEPAK 6s synchronized cardioversion.

A. Connect the ECG Monitor and Defibrillator units together.

B. Depress the POWER pushbuttons on both ECG Monitor and the Defibrillator. The Defibrillator will turn on in manually triggered non-synchronized standby mode.

C. Connect patient to patient cable and set LEAD SELECT switch to desired lead.

WARNING

Do not use Quick-Look defibrillator paddles as ECG pickup for elective cardioversions. Once the discharge push-buttons are depressed, artifact from poor contact or movement of paddles could cause synchronizer to fire Defibrillator prematurely.

D. Depress SYNC pushbutton. Switch light will turn on.

E. Adjust ECG SIZE control as described in paragraph 2-6G until SYNC marker occurs on "R" waveform on the monitor. SYNC pushbutton will flash and SYSTOLE sound will beep with marker. (It may be necessary to move the electrodes to get a signal with sufficient amplitude.) If SYNC marker occurs anywhere other than on the QRS, select another lead with ECG LEAD SELECT switch.

F. Select energy to be delivered with ENERGY SELECT switch (2).

G. Depress and release CHARGE pushbutton (3) either on Defibrillator front panel or on APEX Paddle.

H. To apply the synchronized charge to the patient, depress both discharge pushbuttons and hold until the Defibrillator fires on the next "R" wave. Defibrillator will fire within 20ms of marker. Release both pushbuttons.

After discharge, the Defibrillator automatically returns to the normal defibrillate mode. If another synchronized cardioversion is required, place the Defibrillator in the SYNC mode again by de-pressing the SYNC pushbutton. When the switch light turns on, synchronizer is on.

IMPORTANT NOTE

When testing the synchronized charge, the normal synchronized cardioversion procedure is followed using the patient's ECG signal and placing the Defibrillator in the synchronous mode. However, the Defibrillator is then discharged into the TEST LOAD. It should be noted that the resulting trace recorded on the chart may show a small, narrow spike (see 2 on Diagram below) which is an artifact resulting only from the test. This spike, 2, does not represent the energy transfer. The actual transfer is 200ms before this mark.

The LIFEPAK 6s is fully compliant with the 1981 American National Standard for cardiac defibrillator devices including synchronized cardioversion, which requires initiation of the discharge within 30ms of the synchronizing signal.

1."SYNC" MARKER EXTENDING TOP OF "R" WAVE
2. SPIKE

2-9. OPERATOR SERVICE

The following paragraphs provide operator service procedures including daily operational checkout, recorder paper replacement and recorder stylus adjustment and replacement.

2-10. Operational Checkout. Tables 2-5 and 2-6 provide operational checkout procedures for the ECG Monitor and DC Defibrillator units. Table 2-7 provides an operational checkout for Monitor and DC Defibrillator units connected for verification of synchronized cardioversion.

These procedures will determine whether or not the Monitor and DC Defibrillator units function normally. These tests should be performed as routine maintenance. The operational checkout procedures are presented in tabular form to allow the user to copy them and use them as preventive maintenance aid.

TABLE 2-5

ECG MONITOR UNIT OPERATIONAL CHECKOUT

PROCEDURE	RESULTS
1. Turn ALARM LIMITS to OFF position and QRS VOL control counter-clockwise.	
2. Attach Patient Cable to PATIENT CONN connector.	
3. RECORDER switch should be in OFF position.	
4. Set ECG LEAD SELECT switch to STD position.	
5. Depress POWER pushbutton.	Verify luminous trace appears on CRT. Observe BATT LEVEL indicator for adequate battery voltage with power cord disconnected. With power cord connected to proper AC power source, verify that the BATT CHG indicator is illuminated.
6. Depress 1mV (PUSH) pushbutton. Set ECG SIZE to x1 position.	Square wave should appear on CRT.
7. Set RECORDER switch to DIAG.	Check that Recorder starts. If paper replacement is required, refer to paragraph 2-11.
8. Depress 1mV (PUSH) pushbutton.	a. Check that a square wave is printed on Recorder. Wave should be 10mm high. b. Adjust QRS VOL so that "beep" tone is heard with each 1mV signal.

TABLE 2-5 (Continued)

ECG MONITOR UNIT OPERATIONAL CHECKOUT

PROCEDURE	RESULTS
9a. Turn recorder switch to AUTO. b. Adjust LOW ALARM LIMITS from OFF position.	 Check that the audio alarm and recorder are on. Recorder will run from 13 to 23 seconds.
10a. Set ECG LEAD SELECT switch to position I. b. Place snap ends of white lead and black lead wires together. c. Repeat step a above with ECG LEAD SELECT switch to position II. d. Place snap ends of white lead and red lead wire together. e. Repeat step a above with ECG LEAD SELECT switch to position III. f. Place snap ends of black lead and red lead wire together.	a. Verify interference is present on Cardioscope trace with 4 or 5 lead cable. b. Trace on CRT should stabilize. c. Verify interference is present. d. Trace on CRT should stabilize. e. Verify interference is present. f. Trace on CRT should stabilize.
11. Return ECG LEAD SELECT switch to STD.	
12. Turn RECORDER AUTO/DELAY/DIAG. switch to DELAY.	Check to see if Recorder starts and trace appears within 1 1/2 seconds. Depress 1mV (PUSH) pushbutton several times and verify that the square wave pulse appears on CRT and is recorded on the ECG paper within 5 seconds.
13. Set RECORDER switch to OFF.	
14. Press POWER pushbutton off.	

TABLE 2-6

DC DEFIBRILLATOR UNIT OPERATIONAL CHECKOUT

PROCEDURE	RESULTS
CAUTION Do not apply gel to paddles. Use firm contact at time of discharge on test load plates to prevent arcing, pitting of paddles, and to insure proper delivery of energy.	
1. Check that clean, dry paddles are firmly seated in storage area.	
2. Disconnect power cord from outlet and check that BATT LEVEL indicator is in green zone to indicate adequate battery capacity. Restore power cord to proper grounded AC power outlet and check that BATT CHG indicator is illuminated. Depress POWER pushbutton (1).	
3. Set ENERGY SELECT rotary switch (2) to maximum energy.	
4. Depress CHARGE pushbutton (3).	Check that switch flashes until fully charged and then glows steadily. Check that charge indicator on APEX paddle also flashes until fully charged. Check that energy display increments increase, that selected energy is indicated at full charge, and that AVAILABLE ENERGY is lit. Verify charging time is less than 10 seconds.
5a. With clean, dry paddles firmly seated on Test Load plates in storage area, depress both paddle discharge pushbuttons simultaneously. 5b. Repeat steps 3,4, and 5a at 100 joules.	Verify TEST LOAD illuminates and energy display indicates selected energy. Bars in display indicate unit requires calibration. **CAUTION** Because of heat created at time of discharge into Test Load, do not repeat testing of Defibrillator more than ten 360 joules discharges every hour at room temperature.

TABLE 2-7

ECG MONITOR AND DC DEFIBRILLATOR OPERATIONAL CHECKOUT

PROCEDURE	RESULTS
NOTE: The ECG Monitor and Defibrillator units must be interconnected for the following operational checkout.	
1. Push ECG Monitor unit POWER pushbutton on.	
2. Set ECG LEAD SELECT switch to PADDLES	a. Verify that by touching one paddle face, the CRT trace shows interference. b. Repeat step a above with the other paddle face. c. Place Paddle faces together. Check that the interference trace on CRT disappears.
3. Connect patient cable snaps to ECG simulator and 6 pin connector to PATIENT CONN on ECG Monitor unit.	Observe CRT for ECG signal.
4. Depress Defibrillator POWER pushbutton (1).	Check that switch illuminates.
5. Depress SYNC pushbutton on Defibrillator.	Check that the marker blip appears on the Monitor CRT and SYNC indicator lights up on Defibrillator panel. Sync light flashes off with each "R" wave.
6. Set ENERGY SELECT switch (2) to 100 joules.	
7. With paddles firmly pressed onto test load plates in storage area, depress both Paddle Discharge pushbuttons simultaneously.	Check that defibrillator discharges on the next "R" wave and that the energy display indicates 100.
8. Following energy discharge check that the Defibrillator returns to the normal defibrillate mode.	Check that SYNC light is out on Defibrillator front panel. Check that marker has disappeared from CRT display.

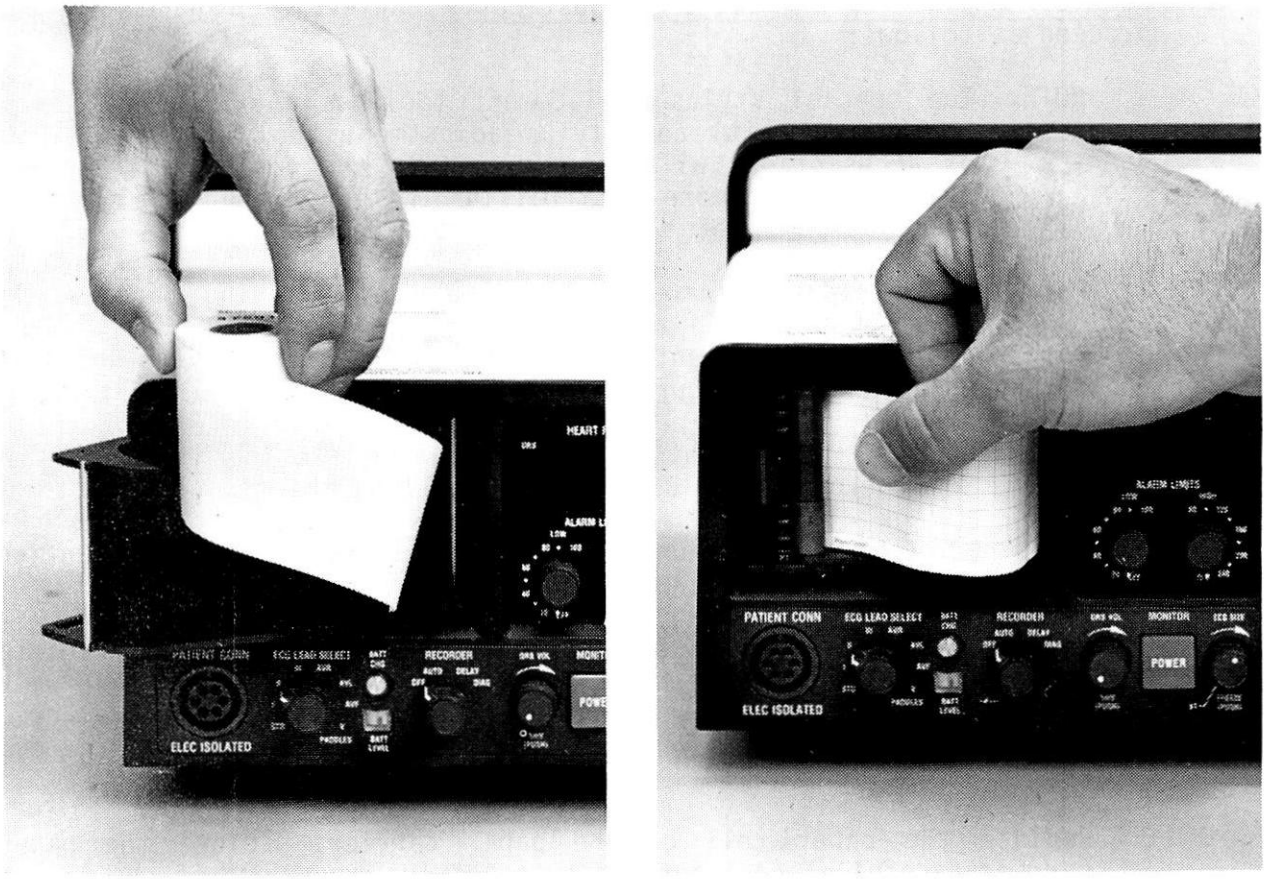


FIGURE 2-6. RECORDER PAPER REPLACEMENT

2-11. Recorder Paper Replacement. Refer to Figure 2-6 and proceed as follows.

A. Open the paper carrier at the right hand side.

B. Remove the old paper roll.

C. Replace with the new paper roll so that the recorder paper comes off the roll in a counterclockwise direction.

D. Pull out a short length of paper over the roller guide on the edge of the paper carrier, and close the paper carrier.

E. Depress the POWER pushbutton. Set the RECORDER switch to the DELAY position and the ECG LEAD SELECT switch to the STD position. While the recorder is running, guide the paper under the rubber roller. The paper will be pulled through by the rubber roller which is the paper drive. Turn the RECORDER switch to OFF.

2-12. Recorder Stylus Replacement and Adjustment. Refer to Figure 2-7 and proceed as follows:

NOTE: The special stylus replacement tool (part of the replacement kit) and stylus adjustment tool (part of accessories) will be required in the following procedure. For more detailed information, refer to instruction sheet accompanying replacement stylus.

A. Pull out the paper carrier and remove the remaining paper roll.

B. Push the stylus replacement tool onto the tip of the stylus until it is hooked as shown in Figure 2-7A.

NOTE: A small flashlight will help in positioning the tool onto the stylus and in installing the stylus.

C. Pull gently on the tool until the stylus loosens from its mounting and extract the stylus. Remove the stylus from the tool.

D. Install the new stylus on the tool per Figure 2-7B. Use the tool to position the stylus so that the dovetail on the stylus lines up with the dovetail on the stylus mounting block. Using the stylus tool, push gently until the stylus is snugly seated. Check that the tab on the replacement tool is even with the recorder housing.

E. Replace the paper roll on the paper carrier. Close the paper carrier carefully and insure that the stylus moves out of the way of the writing edge and comes in contact with the paper when the paper load carrier is shut. If the stylus does not touch the paper, lift the paper load carrier and adjust the middle stylus tension screw clockwise to increase the pressure. See Figure 2-7C.

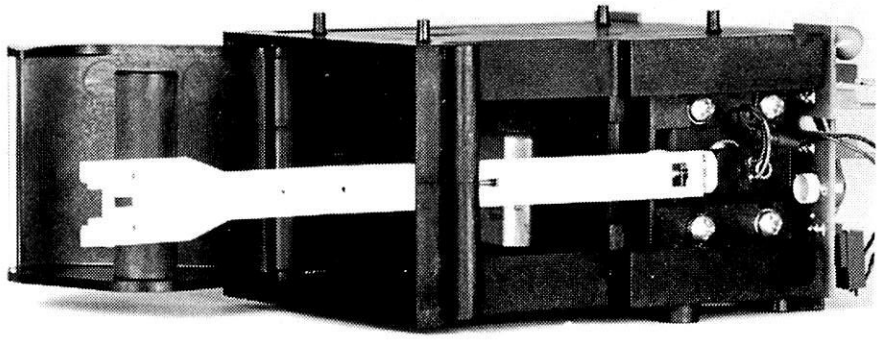
F. Adjust the stylus temperature control as necessary (see Figure 2-7D). Using the stylus adjustment tool, adjust the stylus heat control potentiometer through the white locator ring, slightly below and behind the base of the stylus. A light line will provide longer life.

G. Place ECG LEAD SELECTOR switch to PADDLES position. Set RECORDER switch to ON and let recorder run while depressing the 1mV (PUSH) switch. Observe deflection and compare with diagram below.

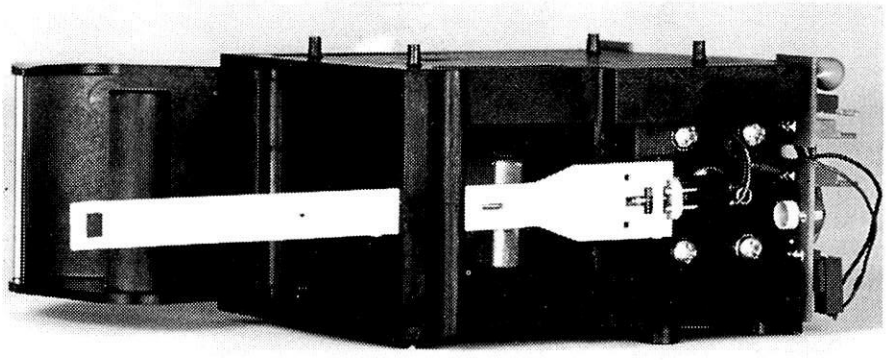
H. Adjust stylus tension screw if necessary. Repeat step G above.

NOTE: To insure AHA frequency response, adjust the stylus pressure to 4-6 grams using a gram gauge and check response to AHA specifications.

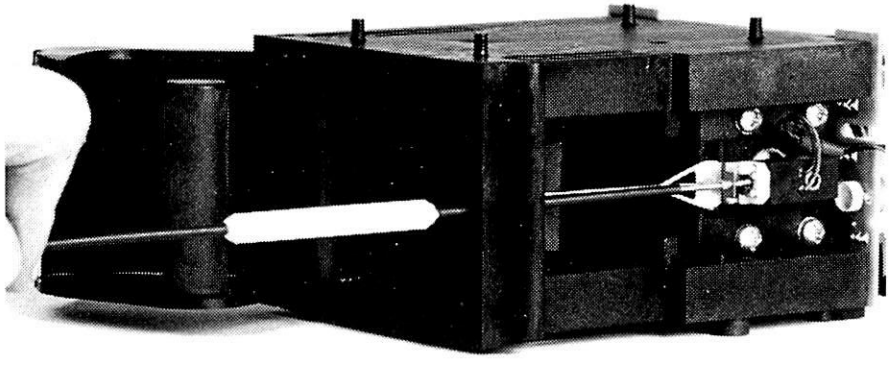
ACCEPTABLE (NOMINAL) | TOO LITTLE PRESSURE | TOO MUCH PRESSURE



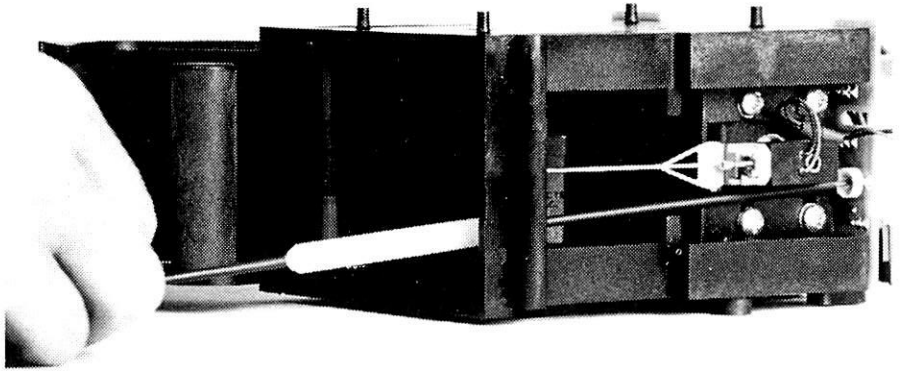
STYLUS REMOVAL (A)



STYLUS INSTALLATION (B)



STYLUS PRESSURE ADJUSTMENT (C)



STYLUS TEMPERATURE ADJUSTMENT (D)

FIGURE 2-7. STYLUS REPLACEMENT AND ADJUSTMENT

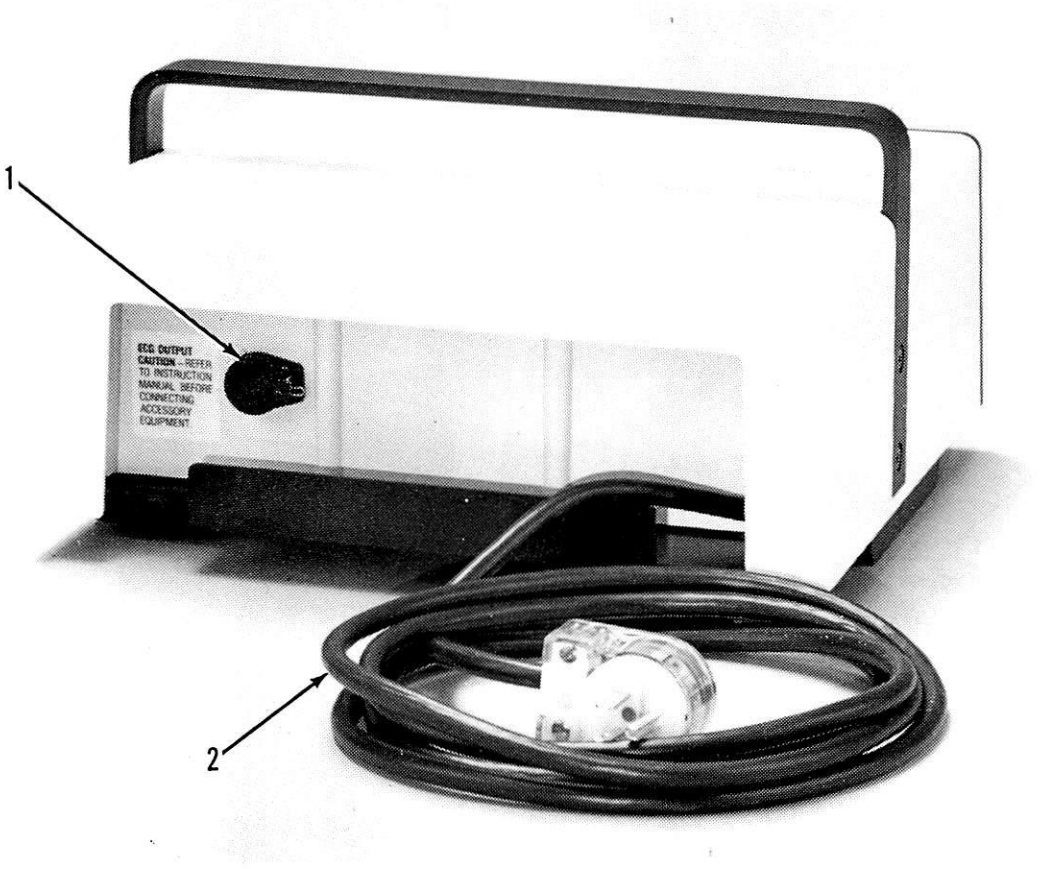


FIGURE 2-2A. ECG MONITOR UNIT REAR PANEL

TABLE 2-2A

ECG MONITOR UNIT REAR PANEL

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	ECG OUTPUT	ECG output jack for connecting external monitoring equipment.
2	AC Power Cord	Connects unit to grounded AC power source receptacle or to Defibrillator power receptacle, item 2 Table 2-4.

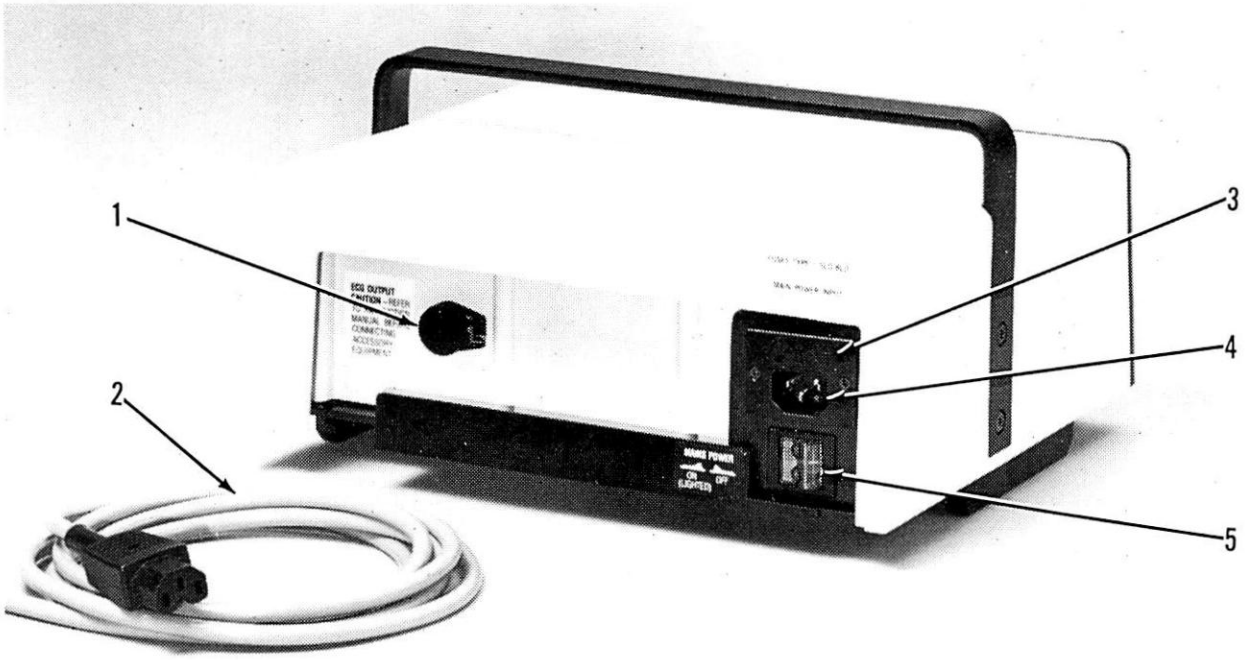


FIGURE 2-2B. ECG MONITOR UNIT REAR PANEL

TABLE 2-2B

ECG MONITOR UNIT REAR PANEL

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	ECG OUTPUT	ECG output jack for connecting external monitoring equipment.
2	Mains Power Cord	Connects unit to AC mains power sources.
3	Mains FUSES	Mains voltage/current surge protection.
4	MAINS POWER INPUT	Mains Power Cord or Unit Interconnect Power Cable plugs in here.
5	MAINS POWER Switch	On/Off Switch for AC mains. Illuminates when switches on.

NOTE: Mains Power Cords may differ, depending on the local requirement.

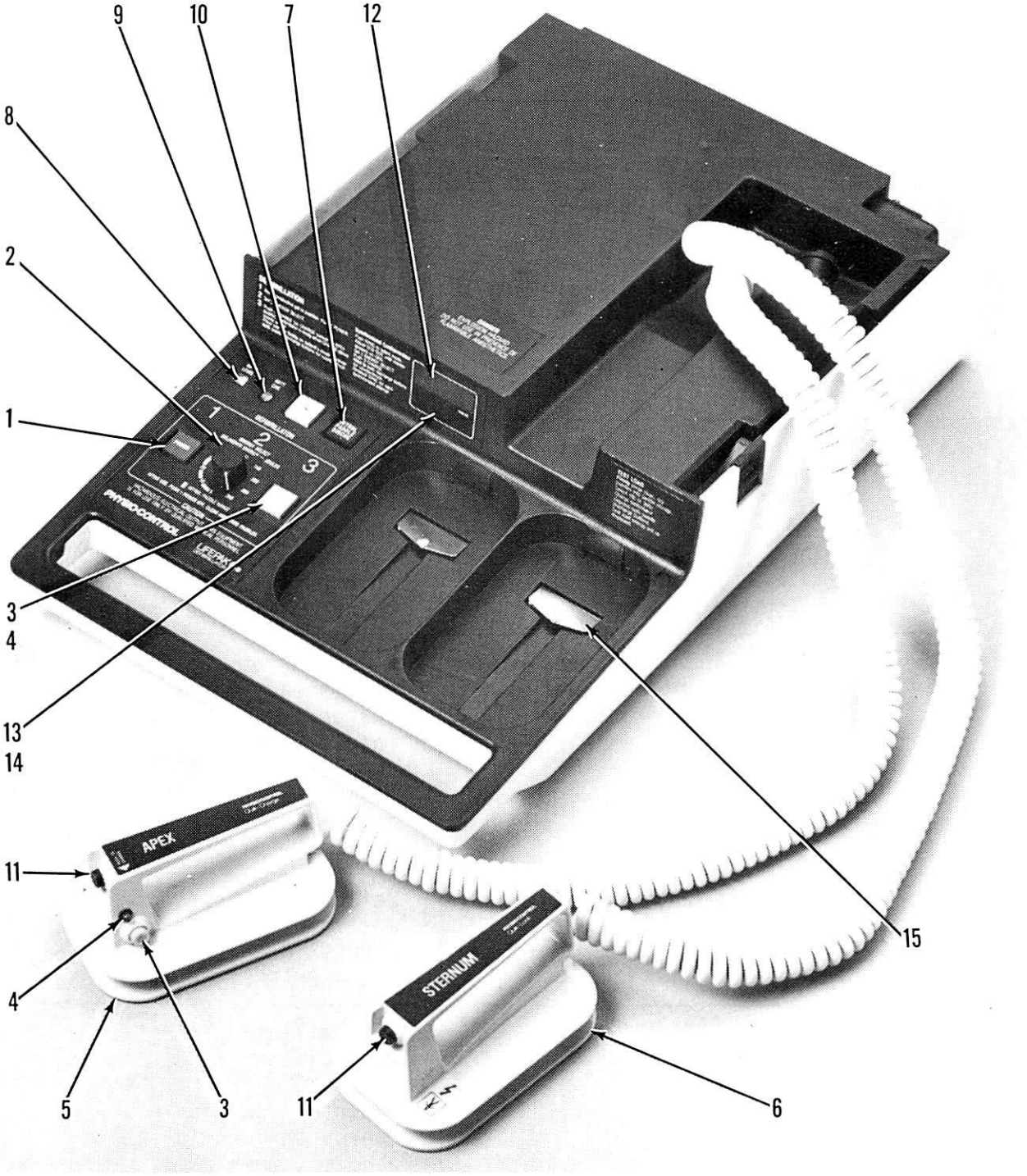


FIGURE 2-3. DC DEFIBRILLATOR UNIT CONTROLS AND INDICATORS

TABLE 2-3

DC DEFIBRILLATOR UNIT CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	POWER Pushbutton/Indicator	Illuminating switch applies power to instrument.
2	ENERGY SELECT	Rotary switch with 10 discrete energy levels selectable: 5, 10, 20, 30, 50, 100, 150, 200, 300, 360 joules delivered. (Optional 400 joules.) Interlock prevents selection of 100 and above when using internal paddles.
3	CHARGE Pushbuttons	Momentary switches to charge Defibrillator to selected level. If ENERGY SELECT 2 is changed after instrument is charged, charge will be internally discharged and recharge will be necessary.
4	CHARGE Indicators (on control panel and APEX Paddle)	Flash during charge cycle, give steady light when fully charged; extinguish approximately 64 seconds following completion of charge if unit has not been discharged, indicating unit is not ready and must be recharged.
5	APEX Paddle	Defibrillating electrode with a discharge pushbutton, a PUSH TO CHARGE pushbutton, and a CHARGE indicator.
6	STERNUM Paddle	Defibrillating electrode with discharge pushbutton.
7	INTRNL PADDLE DSCHG	Momentary switch to apply energy through intrenal paddles, when used. Interlock prevents use with other paddles.

SECTION 2
OPERATION

2-1. GENERAL

This section provides information and procedures to properly operate and provide operator service for the LIFEPAK 6s ECG Monitor and DC Defibrillator units.

2-2. CONTROLS AND INDICATORS

The following paragraphs provide a brief description of the controls and indicators.

A. The controls and indicators for the ECG Monitor unit are shown in Figure 2-1. Each control and indicator in the figure corresponds to the listing in Table 2-1. The table lists each control or indicator and briefly describes its functions.

B. Figure 2-2 is the rear panel view of the connections for external ECG recording. Each item in the figure corresponds to the listing in Table 2-2. The table lists the item and briefly describes its function.

C. The controls and indicators for the DC Defibrillator unit are shown in Figure 2-3. Each control and indicator in the figure corresponds to the listing in Table 2-3. The table lists the control or indicator and briefly describes its function.

D. Figure 2-4 provides the rear panel view of the DC Defibrillator unit. Each item in the figure corresponds to the listing in Table 2-4. The table lists each control and briefly describes its function.

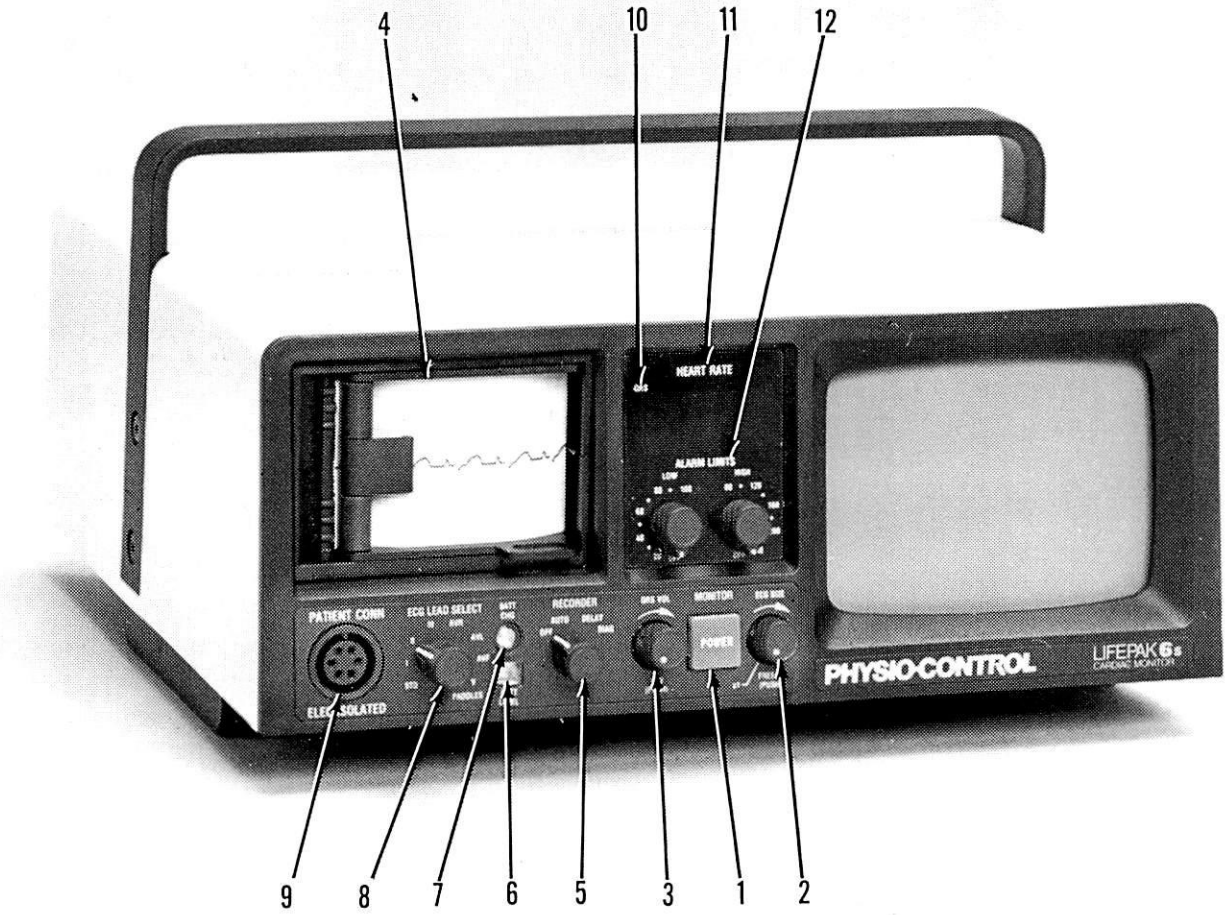


FIGURE 2-1. ECG MONITOR UNIT CONTROLS AND INDICATORS

TABLE 2-1

ECG MONITOR UNIT CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	POWER Pushbutton	Switch (non-illuminating) applies power to instrument.
2	ECG SIZE	Used to adjust the signal amplitude (vertical) on the CRT and Recorder simultaneously. Turn clockwise to increase amplitude. The X1 setting at the full counter-clockwise position provides a calibrated detent at 1mV/cm on the chart recorder.
	FREEZE (PUSH)	Push and hold button which freezes trace on CRT. Release resumes current trace.
3	QRS VOL	Used to adjust sound volume of systole beeper. Turns clockwise to increase volume.
	1mV (PUSH)	Push and hold knob. Activates a positive 1mV test signal fed to both CRT and Recorder, which is convenient for calibrating both with ECG SIZE. Use with STD ECG lead to eliminate any patient lead ECG signal.
4	Recorder	Records ECG on standard heat sensitive paper.
5	RECORDER OFF/AUTO/DELAY/DIAG.	Rotary switch controls Recorder on/off and bandwidth.
	DIAG	Diagnostic (.05 to 100Hz) bandwidth recordings in real-time.
	DELAY	Monitor (.5 to 40Hz) bandwidth recordings with a 5 second delay. The ECG waveform appears to leave the left side of the CRT and appear on the recorder.

TABLE 2-1 (Continued)

ECG MONITOR UNIT CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
5 (Cont.)	AUTO	Chart recorder is automatically turned on in the DELAY mode when heart rate alarm limit is exceeded. Recorder shuts off automatically after running 13 to 23 seconds and automatically turns on again if another alarm occurs after that time.
	OFF	Stops recorder and resets AUTO timer.
6	BATT LEVEL	The indicator should be observed with the POWER switch on: Marker in green zone indicates good battery; marker in red zone indicates low battery. A low battery can be fully charged in 16 hours by connecting power cord to a proper AC power source (grounded).
7	BATT CHG	Indicator which illuminates when battery is charging.
8	ECG LEAD SELECT	Rotary switch for selecting PADDLES input or patient cable leads; STD, I, II, III, AVR, AVL, AVF and V.
9	PATIENT CONN	Connection for 6 pin patient cable (electrically isolated).
10	QRS Indicator	Flashes when QRS sensed.
11	HEART RATE	Displays QRS rate from 20 to 300 BPM.
12	ALARM LIMITS	Switches for selecting HIGH and LOW heart rate limits. Exceeding the preset heart rate alarm limits will cause a continuous audio alarm. If set on AUTO, the recorder will also start.

SECTION 3
CIRCUIT DESCRIPTION

3-1. INTRODUCTION

This section provides a detailed description of the circuits contained in the Monitor and DC Defibrillator units. The section is divided into three major parts. A brief general description of each unit of the system is presented first, accompanied by a block diagram. The subsequent detailed descriptions of the Monitor and the Defibrillator units are presented in turn.

3-2. FUNCTIONAL DESCRIPTION

The block diagrams in Figures 3-1 and 3-2 provide an overall view of the system operation in terms of the ECG Monitor and DC Defibrillator Units. Schematic diagrams of the major circuits are provided in Section 6. Refer to the Schematic while reading the circuit description.

NOTE: In some instances the schematics may differ slightly (e.g., component values) from the equipment supplied. This occurs if the schematic in question is a different revision from the one presented with the text. The applicable configuration or interim change(s) will be given in the Difference Data section at the rear of the manual. From time to time, this information will be incorporated into the manual as a revision.

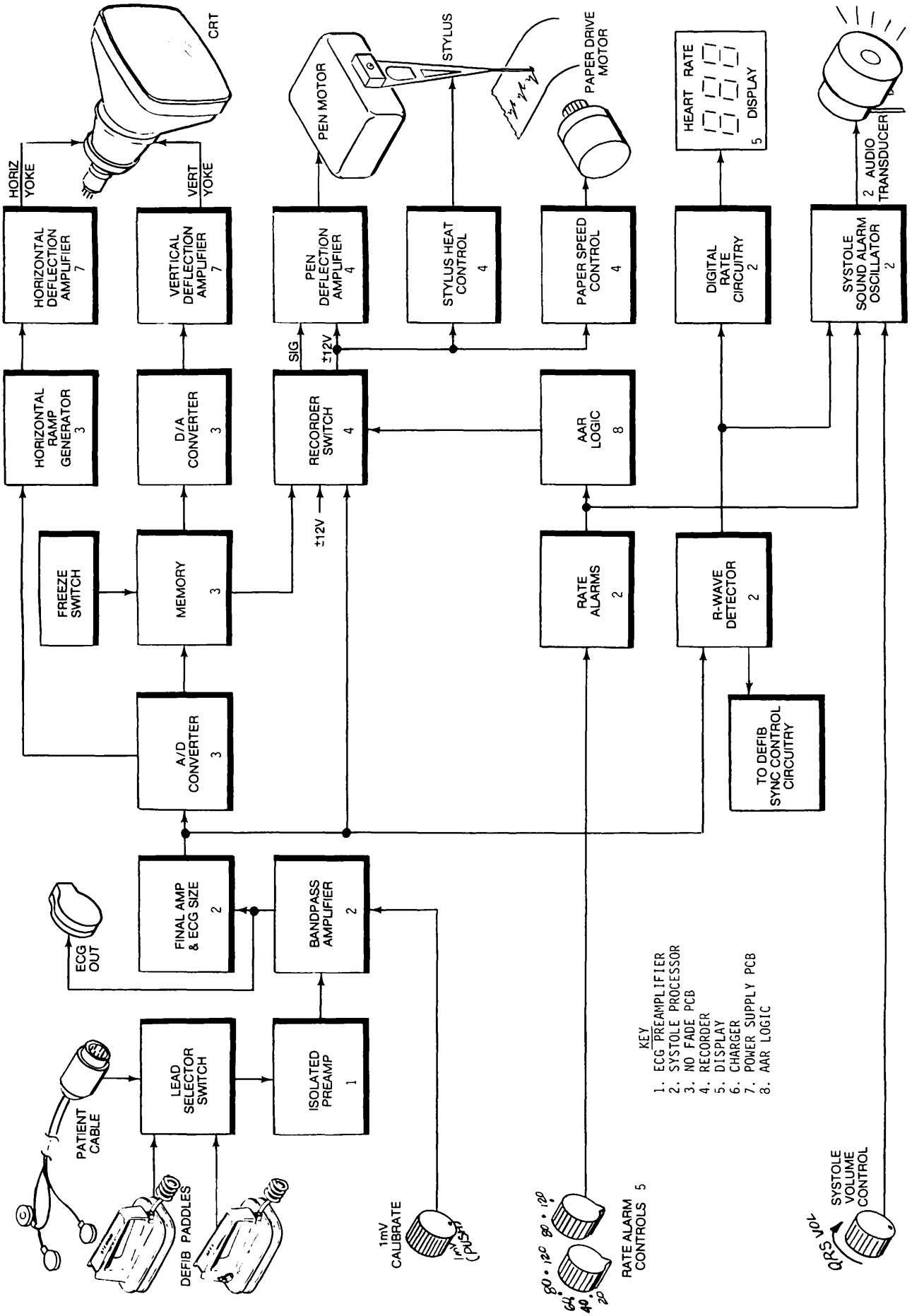


FIGURE 3-1. ECG MONITOR - BLOCK DIAGRAM

3-3. ECG Monitor Circuits. The ECG Monitor circuit functions shown in Figure 3-1 are performed by the (1) Preamplifier, (2) Systole Processor, (3) No-Fade, (4) Recorder, (5) Display, (6) Charger, (7) Power Supply and Deflection Amplifier, and (8) Alarm-activated Record Logic PCBs, as well as front panel controls and displays. The numbers 1 through 8 assigned to individual blocks in Figure 3-1, correspond to the numbers in the above listing of PCBs. They indicate on the block diagram which PCB contains the circuits for a given function and show how the circuits of each PCB fit into the system.

The 800101 (801873) Preamplifier PCB Assembly accepts ECG signals from the patient, through a five-lead cable or the Defibrillator Paddles, preamplifies the signal to reject all common-mode, spurious dc and power-line-frequency interference or EMI, then provides electrical isolation between the patient and subsequent amplification and signal processing.

The 801445 Systole Processor PCB Assembly provides ECG final amplification, signal calibration, and CRT display size control. In addition, it detects the "R" wave portion of the ECG for each successive systole event, generates cardioversion synchronizing pulses for Defibrillator use, and produces systole sound, a heart-rate alarm, and heart-rate digital outputs.

The 800159 No-Fade PCB Assembly samples the ECG at a high rate, converts each sample to digital form, and stores successive samples in memory. It reads out the stored memory data representing the last 5 seconds of ECG signal, converts it to analog form, and generates a horizontal sweep ramp used as a time base for the CRT display showing 5-second delayed ECG signals.

The 800112 Power Supply Assembly provides dc supply voltages, CRT anode voltages, and amplification for CRT deflection signals.

The 801584 Recorder PCB amplifies the ECG signal for application to the Recorder. The ECG signal may be in real-time (diagnostic bandwidth), which is obtained from the Systole Processor PCB or be delayed (monitor bandwidth), which is obtained from the memory in the No-Fade PCB. The Recorder PCB also controls recorder stylus heating and Recorder paper constant speed drive.

The 801546 Alarm-Activated Record Logic (AAR) PCB Assembly controls automatic chart recording during any heart-rate alarm conditions.

The 801904 Display PCB Assembly controls the digital display of the heart-rate and the light-blink displayed for each heart beat. The 800157 Charger PCB Assembly rectifies AC line power, charges a battery used as an alternative energy source, selects this alternative energy source when line power is unavailable, and monitors battery status.

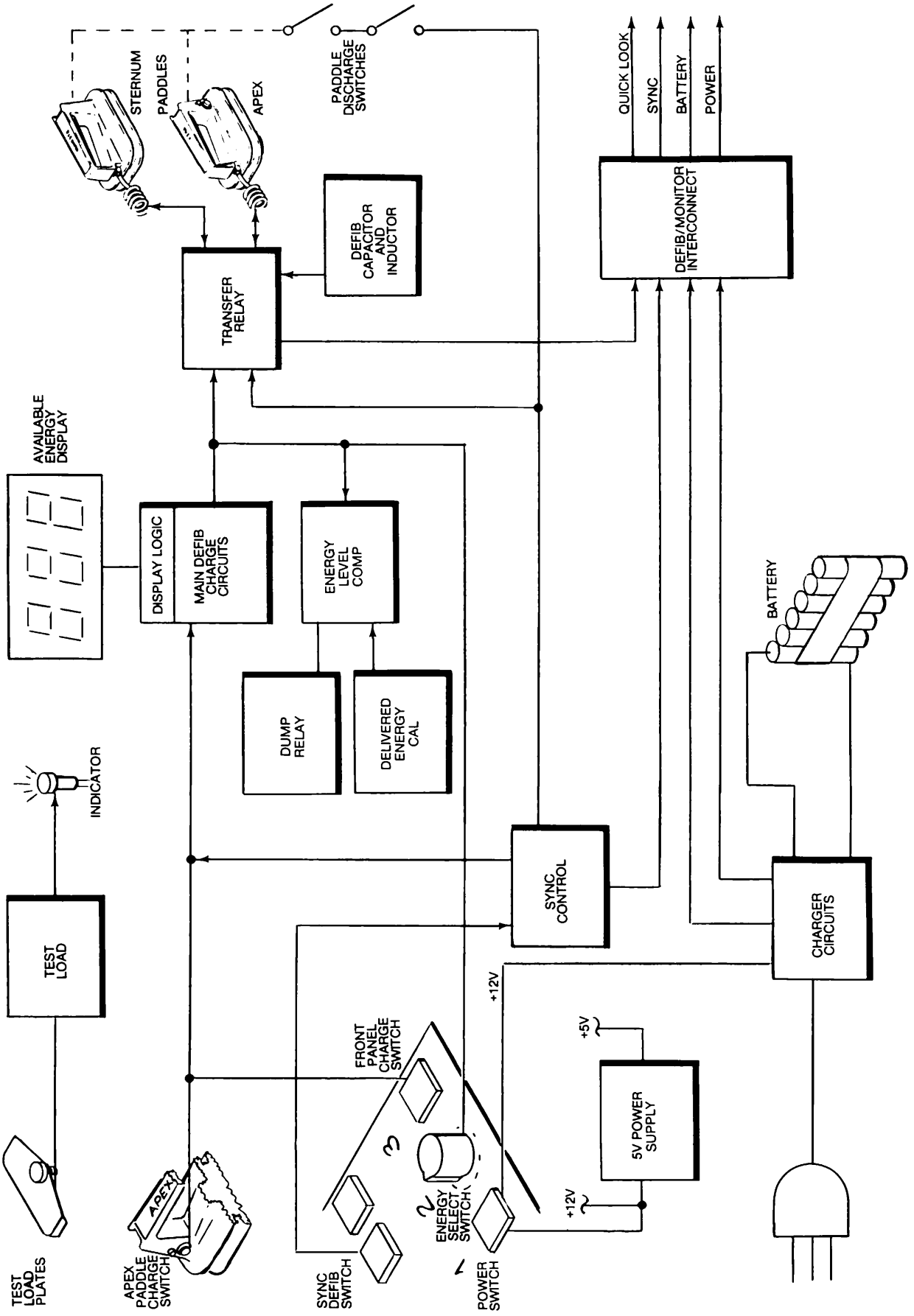


FIGURE 3-2. DC DEFIBRILLATOR BLOCK DIAGRAM

3-4. Defibrillator Circuits. The Defibrillator circuits consist of the 801851 Control Panel, a high-energy storage capacitor and inductor, the 800041 (801505) Charger PCB, the 801820 Main Defibrillator PCB, the paddles, a transfer relay for discharge of the storage capacitor, an 801843 Energy Meter PCB Assembly, the 801841 Test Load PCB, and a one-ampere hour 12V battery. Figure 3-2 is a functional block diagram showing basic Defibrillator operation.

The +12V output from the 800041 (801505) Charger PCB is the dc voltage supply for all circuits in the Defibrillator Unit. To supply +12V, the charger must either operate from AC line power or the battery. Depression of the POWER switch on the front panel applies +12V to the Defibrillator Main PCB circuits and +12V passes through a relay, K1, creating various supply voltages. All logic is reset to the standby state when power is first applied.

The 800041 (801505) Charger PCB also maintains the +12V battery charge while operating on AC line power. When AC power is not available the Charger PCB automatically obtains power for Defibrillator circuits from the battery.

The 801820 Main Defibrillator PCB contains all Defibrillator logic circuits and the dc-to-dc converter required to charge the energy storage capacitor. All front panel controls and indicators interface with this assembly.

The 801843 Energy Meter Assembly contains a 3-digit, 7-segment LED display and two LED light bars which indicate AVAILABLE ENERGY and TEST LOAD. BCD-to-7-segment conversion logic is provided by this assembly, but the digits are multiplexed and the light bars are driven by the Main PCB.

The 801841 Test Load Assembly provides a 50-ohm power resistor and a transformer-isolated current sensing network. The assembly provides a signal similar to the Test Load current for Test Load energy calculation by the Main Defibrillator PCB.

3-5. ECG MONITOR - CIRCUIT DESCRIPTION

Paragraphs 3-6 through 3-13 describe the ECG Monitor circuits by individual function, starting with the Preamplifier circuits and continuing through the Systole Processor, No-Fade, ECG Monitor CRT and Recorder display, Rate display, AAR and Power Supply circuits.

The Interconnect Wiring Diagram shown in Section 6 provides complete interconnection data for the assemblies which comprise the Monitor.

3-6. Preamplifier PCB Circuits (800101). The Preamplifier PCB provides input buffering, lead selection, isolated preamplification, common-mode rejection and rejection of AC line power frequencies. (See Figure 6-1A.)

A. Input Buffers and Drive. Connections between the patient-lead electrodes and the ECG Monitor are achieved with a five-conductor cable, each conductor being individually shielded. The ECG input from the patient is channeled to the Preamplifier through four of these leads and a circuit connector, J1. Each of the four input leads are buffered by operational amplifiers, U1. Operated at unity gain, each operational amplifier presents a high input impedance to the patient electrodes and a low output impedance to the Wilson network in the next stage. All four op-amps have characteristics which closely match. This increases the common-mode rejection ratio (CMRR) of the preamplifier.

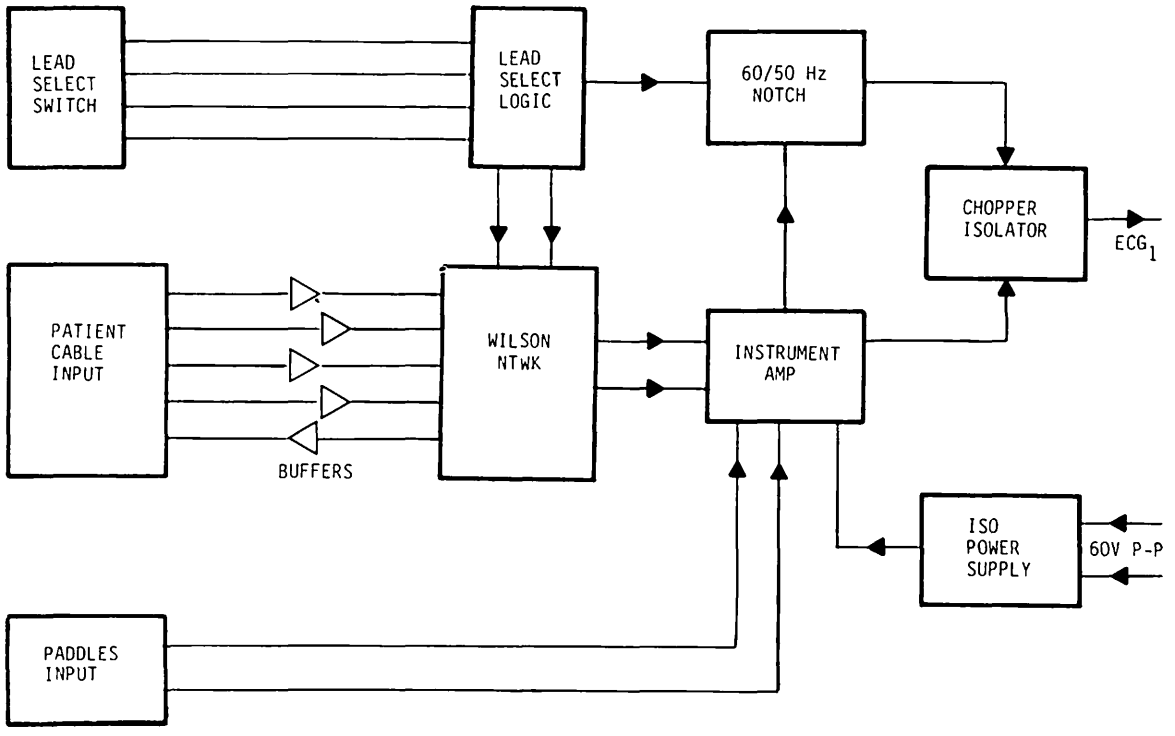


FIGURE 3-3. PREAMP BLOCK DIAGRAM

The three buffered outputs from J1, pins 1, 2, 3 are summed and averaged by resistors R13, R14, and R15. The result, inverted in U2A and applied to J1, Pin 5, provides an output with a common-mode increasing the CMRR of the Preamplifier. In addition, the arm and left leg buffered outputs are connected to the Wilson resistance network which is a summing array. Various network outputs correspond to the various lead input combinations.

B. ECG Lead Selection. The setting of a nine position switch on the front panel selects which sources of input will be transmitted to the ECG preamplifier.

1. In position STD, the amplifier input is short circuited to GND. A 1mV standardization voltage can then be independently applied to a later amplifier stage by operating another front panel control.

2. Each of the next seven positions selects one of the seven possible lead combinations.

3. The final switch position selects the Defibrillator paddles as the ECG signal source.

The seven different lead combinations are switch-selected through diodes CR3-12. In any given setting, a unique one-of-seven binary codes is applied as a control input to pins 9, 10, and 11 of solid-state units, U4 and U5. Electrically, U4 and U5 are each equivalent to multiposition selector switch. The output connection of each appears at Pin 3. Depending on the binary control input, any of the seven combinations of analog signals originating in the V, LL, RA and LA wires can be made available at the U4 and U5 outputs.

The U4 output may be considered as the signal and the U5 output as the reference or signal return. Signal and return paths to the instrumentation amplifier are completed via solid state switches, U6A and B, only when the front panel selector is not set in the PADDLES position. In the PADDLES position the selector connects an 8V control potential to U6C so that the amplifier input is obtained from the defibrillation paddles.

C. Amplification. Whether obtained from the paddles or the patient cable, the signal is applied through U6 to a differential amplifier that employs operational amplifiers U2B, U2C and U2D. After the first stage of amplification, the signal and reference are applied to the differential amplifier, U2D.

Overall, the three op-amps provide a nominal AC gain of 500. The dc rejection circuits feed back through U7 to provide dc cancelling inputs to U2D. The feedback is accomplished via an integrating circuit involving an RC time constant which is determined by the values of R36 and C4 or (for larger dc swings) by a faster reacting circuit involving U9, Q1, and an RC time constant set by R37 and C4.

The normal speed circuit is enabled as long as the absolute value of the output at U2D is less than 3.2V. However, this output level may be momentarily exceeded following defibrillation discharges or lead changes. In that case, the output of window detector U9 switches to +8V, turning on a FET Q1 (see the Systole Processor circuit description for a more detailed explanation of this type of detector). As a result, R37, which is much lower in resistance than R36, is inserted in the RC circuit and greatly reduces its time constant. The resultant quick acting feedback through U7 rapidly restores the U2D output to zero. With zero dc output re-established, U9 output swings low again, turning off Q1 and returning the instrumentation amplifier to normal operation. Common-mode rejection is adjusted at potentiometer R33, in the dc reject circuit. C7 and R46 prevent large, but brief, pacer signals from operating the fast-restore circuit.

When the cable input is selected, the instrumentation amplifier output is conveyed through switch U6B to Q2, the input to the chopper. In this case, the frequency response of the instrumentation amplifier will have a low limit at 0.05Hz.

When the paddle input is selected, the signal is passed through a notch filter, and switched through U8 to Q2. Moreover, the U2D output is connected through U6B to R39. This places R39 in parallel with R36, thereby decreasing the RC time constant in the dc reject circuit by more than tenfold. The low end frequency response limit of the preamplifier is raised to 1Hz, as opposed to the 0.05Hz low-end limit when a cable input is selected. As a result, low-frequency dc variations, often encountered with paddle use, are rejected.

D. Notch Filter. When the paddle input is selected for monitoring, there may be a 50 or 60Hz ripple on the ECG signal. To remove it the instrumentation amplifier output is passed through an active band-reject (notch) filter.

The Preamplifier circuit employs operational amplifiers U10A, B, C & D, and U11. The first op-amp stage divides the input in a fixed proportion on all frequencies so that the signal to the next three stages (the filter proper) will not saturate that section. In the filter, multiple feedback circuits involving U10B, high-gain U11 and U10C produce a sharp band-rejection at 60Hz (or 50Hz for European applications). The stability of the filter remains, even if circuit component values drift with time. Following the filter stages, U10D restores the signal at U10A to its original input level. The U10D output is switched through U8 to the isolation chopper.

E. Isolation Chopper. The low frequency ECG signal first modulates a higher carrier frequency and is then applied to an isolation transformer. The ECG signal is next chopped by a JFET Q2. The gate of Q2 is driven by the 20KHz Preamp Drive from the secondary of transformer T2. The chopped signal is passed through T1 and sampled

by a JFET, Q3, (driven by the primary of T2). The sampled signal is fed to the Systole Processor PCB where a low-pass filter removes the 20KHz sampling component.

F. Isolated Power Supply. The output of T2 feeds the isolated Preamplifier Power Supply. Full-wave rectifiers, CR18-21, and two capacitors, C8 and C9, form the unregulated ± 15Vdc supply. Regulation of the ± 8Vdc supply is provided by U12 and 13.

3-6A. Preamplifier PCB Circuits (801873). Refer to schematic diagram Figure 6-1B. Signals from the patient leads are routed through the patient connector and ECG flex circuit to J1. VSPs on the ECG flex limit potentials on these leads to 90 volts. The four leads, the RL drive and the patient cable shield are all routed through lead select switch, SW1, which isolates the patient connector from the preamplifier in paddles mode. U1 buffers the signals, reducing the influence of differences in electrode impedances, and drives the Wilson network with a low source impedance. RN1 provides bias current for the buffer inputs, while RN2 limits current to the inputs. Signals from the Wilson network are selected by two decks of SW1 and applied to a differential amplifier comprised of U2A, B and C. In paddles mode the amplifier receives its signal from the Defibrillator paddles through J2. R1 and R2 limit risk currents in accordance with agency requirements. C1 filters high frequency noise from the defibrillator, while RN6, R38 and R39 provide bias current and protection for U2A and U2B.

U2A and U2B form a pair of high-input impedance amplifiers whose gain is set by RN4 and R6. U2C amplifies the differential signal from U2A and U2B and rejects the commom mode signal from them. Overall gain through U2A, B and C is 500 for differential signals and 1 for common mode signals. RN5B and C extract a common mode signal which is inverted and amplified by U2D and used to drive the RL electrode, which helps to cancel common mode signals at their source. In paddles mode this signal is coupled through RN6A and B to the paddle signal lines.

A. DC Restore Operation: Diagnostic quality ECG monitoring through the patient leads requires a low frequency response down to 0.05Hz. U4 output is adjustable at potentiometer R10.

R11 and RN8 form a T-network, simulating a large value resistor, which in conjunction with C7 provides the required 0.05Hz limit. The large resistance values involved in this circuit require special care to minimize leakage currents at the input of U4. For this reason all connections to the inverting input of U4 and those to R11 are coated. U4 is chosen for its low input bias current rating. The outputs of U2A and U2B can swing close to the supply voltages when large input signals are applied to the preamplifier. To allow U4 to control the amplifier under these large signal conditions, RN5A and R7 divide the output of U2A, while RN5D, R9 and R10 divide the output of U2B.

To minimize the effect of noise produced when changing positions of the lead select switch, R14 is switched into the feedback cirucit briefly by U3B whenever the lead select switch is rotated. All decks of the lead select switch have shorting contacts except for SW1-9 so that RN10A turns on Q4 as the switch changes positions, charging C9 and turning on U3B. When Q4 turns off, RN10B discharges C9 and turns U3B off.

B. Fast Restore/Post-Defibrillation Recovery: U6A is a window detector which reacts to signals larger than approximately 3 volts. RN9A and R19 bias the noninverting input of U6A positive, while RN9B and R20 bias the inverting input negative. Normally output of U6A is off or high. The output goes low when a positive signal raises the inverting input of U6A above the bias level of the noninverting input, or when a negative signal lowers the noninverting input below the bias level of the inverting input.

When U6A goes low, C16 is charged through CR8 to a voltage set by RN10D and R21. The noninverting input of U6B is biased by R34 and R36. Normally the output of U6B is low, but when C16 is pulled low by U6A, the output of U6B goes high, allowing RN9D to turn on U3A and insert R12, R13, and Q1 into the amplifier feedback circuit. These components form a T-network whose effective resistance is varied by the resistance of Q1. When the window limit is first exceeded, C16 biases the gate of Q1 low, turning Q1 off, which makes the effective resistance of the T network low. This raises the low frequency cutoff of the amplifier to approximately 20Hz. As C16 discharges through R15 the bias on the gate of Q1 is lowered. This causes the drain source resistance of Q1 to decrease, increases the effective resistance of the T network, and lowers the low frequency response of the amplifier. When C16 discharges to a voltage greater than that set by R34 and R36, U6B goes low and turns off U3A, which returns the amplifier to full diagnostic bandwidth. The output signal of the amplifier is able to recover relatively quickly from an overload experienced during defibrillation, while displaying the higher frequencies of the QRS complex.

C. Signal Modulation: The signal from the amplifier passes through switch U8 to the center tap of the isolated winding of T2. Switch U9 alternately grounds the legs of this winding, generating a square wave through the transformer. On the other side of T2, U10 connects the appropriate phase of the square wave to connector J4, pin 4. U9 and U10 are both driven from the 20KHz preamp-drive signal, at transformer T1. A low pass filter in the next stage of amplification on the Systole Processor removes the 20KHz switching noise from the signal. C14 and C15 ensure that U9 and U10 switch at nearly the same time.

D. Paddles Input: When the lead select switch is set to PADDLES, the input signal often contains low frequency pulses from uneven paddle pressure and line frequency noise to which the paddles are sensitive. In this switch position Q3 is turned on by RN10A, supplying current to opto-isolator U5 and turning on switches U3A and U8. U3A inserts R12, R13 and Q1 into the amplifier feedback as mentioned

above. If no overload is present to activate the window detector, the resistance of Q1 is minimum, causing the amplifier low frequency response to occur at approximately 1.5Hz.

U5 turns Q2 off, blocking the SYNC signal between the Monitor and the Defibrillator. U8 takes its signal from the output of the notch filter in paddles mode. The filter consists of U7 and its associated components. R30 and R31 decouple U7C and U2C respectively from the capacitance of U8 to prevent the amplifiers from oscillating.

E. Power Supplies: A 20KHz square wave signal is generated on the Low Voltage Power Supply PCB and routed to the Preamplifier through J4-1 and 2. CR5 rectifies this signal to provide +15 volt and -15 volt power, filtered by C12 and C13, for the nonisolated circuitry on the PCB. Similarly, CR4, C10 and C11 provide +15 volt and -15 volt power to the isolated circuitry. T1, T2 and U5 form the dielectric barrier between the preamplifier patient-connected circuitry and the rest of the Monitor. These components are all rated at 8000 volts in accordance with agency requirements. VSP4 protects the other barrier components, should potentials greater than 8000 volts be experienced.

3-7. Systole Processor PCB Circuits (801445). The Systole Processor PCB provides ECG amplification, signal calibration, and controls the size of the CRT and Recorder displays. In addition, it detects "R" waves and generates cardioversion sync, systole sound, and digital rate outputs. Figure 3-4 is an overall block diagram of the Systole Processor PCB showing interface with other stages. Figure 6-2 is the schematic of the Systole Processor PCB circuit.

A. Input Bandpass Amplifier. The preamplified ECG signal from P1-17 is applied to an amplifier U1A, through a bandpass filter. R1, C1, C3 and C4 reject frequencies above 800Hz, removing the sampling noise from the preamplifier; C2 blocks frequencies below 0.02Hz for dc stability. The gain of U1A, approximately 2, is adjustable using R76 to provide an overall gain of precisely 1000 from the ECG1 signal. This 1V/mV signal is fed to the ECG OUTPUT jack as ECG 2 on P1-8.

1mV is often used as a signal reference level in ECG interpretation. When the 1mV (PUSH) switch is depressed, P1-6 is connected to -12V. R4 feeds this level to U1A, where it produces a 1V output simulating a 1mV signal.

B. Gain Control Amplifier. The ECG SIZE control potentiometer, on the front panel, is connected to P1-5. U2A output current, in milliamperes, is .51 times the input voltage. When this current is applied to the ECG SIZE control potentiometer, a voltage proportional to the input signal and the potentiometer setting is applied to U2B. U2B is a non-inverting amplifier with a gain of 1.5.

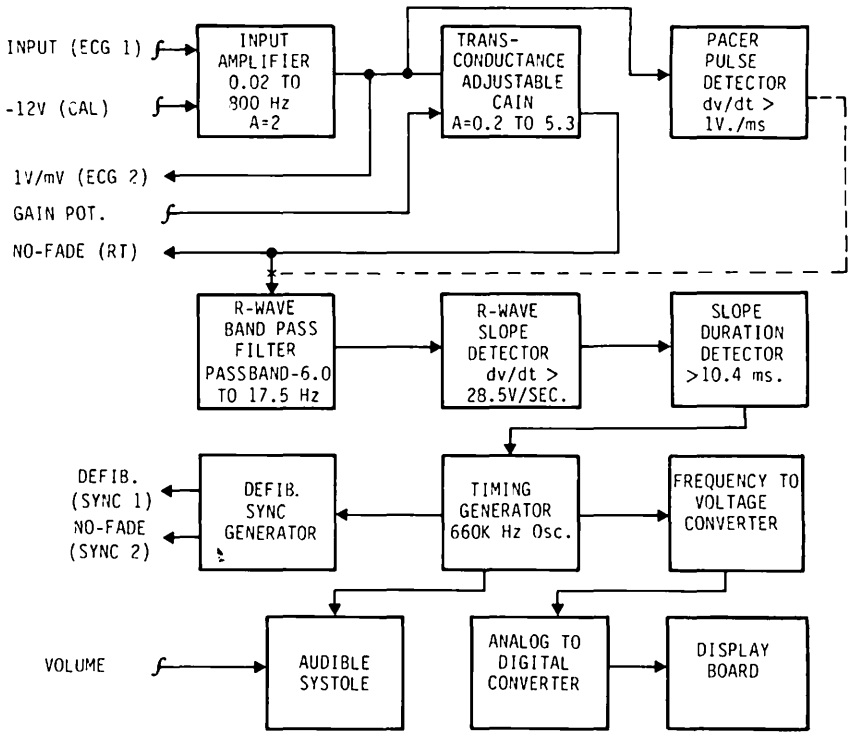


FIGURE 3-4. SYSTOLE PROCESSOR PCB BLOCK DIAGRAM

When the ECG SIZE control is turned fully counter-clockwise, R77 and R90 are used instead of the ECG SIZE potentiometer. R77 adjusts the signal to U2B providing exactly 1cm of deflection on the chart recorder for a 1mV patient signal.

The output of U2B supplies the signal to the No-Fade PCB through P1-3. It also supplies the signal for the "R" wave detector.

C. Pacer Detector. The ECG signal output from U1A is applied to U1B of the Pacer Detector circuit. This circuit consists of three op-amps, U1B, U1C, and U1D. The feedback associated with op-amp U1B is non-linear because of the diodes, CR1 thru CR4 which are controlled by two constant current sources, CR19 and CR20 (set at approximately 100µA). These current sources, in conjunction with capacitor C5, define a slope below which the stage gain is approximately unity and above which the gain approaches the open loop amplifier gain. This slope is approximately 1V/ms.

Amplifier U1C functions as a window detector to respond with a positive output, only when its input exceeds approximately ±5V. This occurs when a slope greater than 1V/ms is detected by U1B. R17 and R19 apply a negative bias to the non inverting input of U1C, while R18 and R20 apply a positive bias to the inverting input to change the output of the detector. A positive signal must pull the non-inverting input above the bias level of the inverting input . Negative signals operate similarly, pulling the inverting input below the negative bias on the non inverting input. Diode voltage drops add to the bias levels in setting the window limits. Amplifier U1D is connected as a monostable multivibrator with a positive-going output lasting approximately 30 milliseconds. This signal is used as the gate drive of V MOS transistors Q1 and Q2. These transistors ground the input signal to the "R" wave detector during each pacer occurrence.

D. R-Wave Detector. "R" wave detection involves filtering, differentiation, slope magnitude detection, and duration detection.

The filtering function involves op-amp stages U4A and U4B. Together they provide a passband from 6 to 18Hz, passing the principal "R" wave harmonic components. Stage U4A provides the high-pass limit; U4B provides the low-pass limit.

Detection of valid ECG waveshapes occurs at U4C. R42 and C13 are the components that sense the slope of the wave. Capacitor C14 passes the relatively low-frequency harmonics of the wave, while rejecting the high-frequency spikes.

U2D is a window detector with an output of -12V unless the signal from slope detector U4C exceeds ±1.2V. It operates in the same manner as U1C described in 3-7.C. When a slope of sufficient magnitude is detected, R47 charges C15 toward +12V. If this slope should last longer than about 11ms, the voltage on C15 will rise enough to cause comparator U3B to change state and produce a signal indicating to U5A that an "R" wave has been detected.

CR13 and CR14 clamp the signal to ground, protecting U5A. R48 and CR12 rapidly reset C15 to -12V.

E. Systole Timing Generator. The systole timing generator consists of a crystal-controlled master clock (U10A, U10B, and Y1) driving a 24-bit countdown string, U12 and U13. From this countdown string a series of pulses is generated for each "R" wave detected. (See Timing Diagram of Figure 3-5).

This sequence is started by the application of a negative signal from the "R" wave detector to U5A. The output from this NAND gate is applied to the D input of U6A, allowing Q to go positive on the next positive-going master clock pulse.

The signal from U6A, pin 1, is applied to pin 9 of U6B through NOR gate U5B. On the second master clock pulse, U6B, pin 12, switches positive. This signal is applied to U5A, terminating the positive signal on pin 1 of U6A and causing U6A, pin 1 to go negative on the third master clock pulse. In this manner, a pulse of two master clock periods is generated at U6A, and applied as a reset to the counter string U12 and U13.

U6B is unaffected by the second transition of U6A because its output is reversed by OR gate U5B. This flip-flop is restored to its initial condition when the counter string has detected 4096 clock pulses following reset (U13, Pin 9 switches high). The signal from U6B is 6.2 ms in duration and is used as the cardioversion sync signal at P1-18 and P1-25.

When the Defibrillator is placed in SYNC mode, it checks to see whether or not a Monitor is connected and turned on by testing the SYNC 1 line. (See the Defibrillator circuit description for a complete description of this testing process.)

When U6B generates a SYNC pulse, Q4 is turned OFF for 6.2ms sending the synchronizing signal to the Defibrillator and to the No-Fade PCB display on the CRT and the chart recorder in DELAY mode. Q3 clamps the SYNC 1 line to 5V during the SYNC pulse. U5A on the Defibrillator clamps the SYNC 1 line low unless the SYNC mode is selected which controls the Monitor SYNC display.

The sample pulse is initiated by the leading edge of the sync pulse applied to the clock input of U7A. It will terminate on the 64th cycle of the master clock following reset, if a 98-microsecond pulse is used in rate calculation. The systole pulse is started by the trailing edge of the sample pulse and is stopped when the counter string, Q18 (U13) , goes high. This produces a 198 ms pulse used for rate calculation and systole tone generation. The pin 13 output of U7B is also fed back to the reset of U6A for spurious "R" wave detection during the normal detection sequence.

The audible systole signal is produced by the gating, in U10D, of the pulse from the systole flip-flop, U7B, and, a 2.6KHz signal derived from the counter, U12 and Q8. The resulting pulse train is buffered by U11F and applied to the base of Q6 through a voltage divider which consists of R64, Q5 and the front panel VOL potentiometer at P1-7. Thus, a tone, which varies in volume, is produced by the audio transducer MT1 for each "R" wave detected.

F. Rate Calculation. The precision pulse derived from the systole flip-flop, U7B, is applied to a pair of analog gates, U8A and U8B. These gates apply a reference voltage of 6.9V to an integrator during each systole pulse. This closely controlled pulse is integrated by R61 and C20 and buffered by U4D to produce a voltage proportional to the heart-rate.

Since some ripple exists because of the pulsed input, a sample-and-hold amplifier, U9, driven by the sample flip-flop, U7A, synchronizes the acquisition of data by the rate-calculation circuit.

The data for the digital rate display is produced by a single-chip analog-to-digital converter, U15. Output from the sample-and-hold, U9, is applied through the scaling potentiometer, R78, to the input of U15. The converter provides binary-coded data and multiplexing signals to the Display PCB.

R87 balances input-offset currents through R78. R88 zeros the internal counter in U15.

The display update rate is controlled by U16A and U16B, whose non-inverting inputs are biased to 4.3V by R67 and 68. R66 charges C22 until the voltage on the inverting input of U16A crosses the 4.3V threshold, forcing the output of U16A low and initiating a conversion within U15. Before conversion, the voltage at the inverting input of U16B is 3.8V. During conversion U15 allows C23 to discharge toward 5V, causing the output of U16B to go low as its inverting input crosses 4.3V. C22 discharges rapidly through CR26, forcing the output of U16A to go high and commanding U15 to hold, although the conversion in process continues until it is completed.

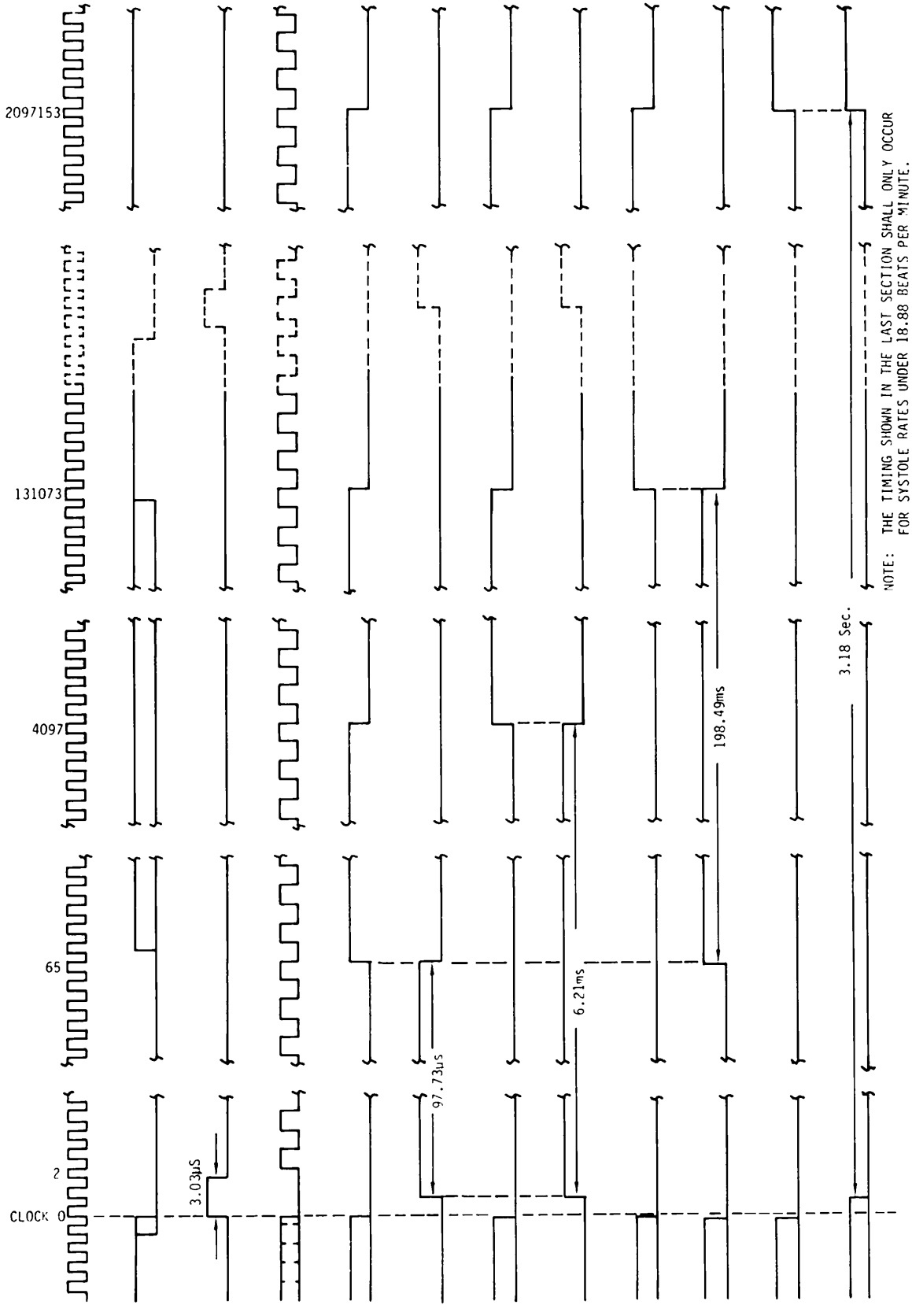


FIGURE 3-5. TIMING DIAGRAM, SYSTOLE PROCESSOR

Once U15 enters the hold mode, Pin 12 charges C23, applying 3.8V to the inverting input of U16B. The output of U16B goes high, allowing R66 to charge C22, repeating the cycle.

G. Low-rate detection. Heart rates below 20 beats per minute are not dislayed. A low-rate detector circuit, consisting of U5C and U5D, is set any time U13 (Q22) of the counter string goes high. This causes the sample-and-hold output to be clamped to ground by the analog gate U8D, and the display to be blanked by Q8. U9 is reset by each sample pulse from U7A, restoring the sample-and-hold signal through the analog gate U8C.

H. Rate-Limit Alarms. Switch-selectable resistors, located on the Display PCB, are used to set the rate-limit alarms. The voltage from the sample-and-hold circuit, U9, is divided by R29 and a resistor which is selected by the HIGH LIMIT switch on the front panel, then applied to the inverting input of comparator U3A. A fixed reference voltage of 0.25V is applied to the noninverting input of U3A. Rapid heart-rates produce a relatively high voltage at U9, and, if sufficiently rapid, cause U3A to pull its output to -12V signalling an alarm. Setting the HIGH LIMIT switch to OFF shorts the inverting input of U3A to ground, preventing operation of the comparator.

The 0.25V reference voltage is applied to the noninverting amplifier, U2C. The gain of U2C which is set by R27 and selected resistor is switched to ground by the LOW LIMIT switch. The heart-rate voltage from U9 is compared with the amplified reference voltage, by the comparator U3C, to produce an alarm signal whenever the voltage from U9 is too low. Setting the LOW LIMIT switch to OFF selects an open circuit from the inverting input of U2C to ground. This gives an amplifier a gain of one. Comparator U3D pulls the inverting input of U3C to -12V, disabling it whenever the output of U2C is less than 0.35V. This is the condition when the LOW LIMIT switch is OFF. C34-C38 and C46 filter the signals to the alarm circuitry preventing false alarms when a heart-rate is close to the set limits, but do not exceed them.

VR2 is used to regulate reference voltages for the alarm-limit circuit. R73-75 and R79 divide the 6.9V level of VR2 into the 0.35V and 0.25V levels used by comparator, U3A and U3C. R79 adjusts the ALARM-LIMIT setpoints for calibration.

The outputs of U3A and U3C are connected so that either U3A or U3B operates the common alarm circuit. The -12V ALARM signal is clamped by CR15 and CR16 and fed to NOR gate U10C which signals the alarm to the audio transducer, MT1. The ALARM signal is also applied to the gate of Q5, turning it off and applying the full drive signal from U11F to the base of Q6, producing maximum loudness from MT1. The ALARM signal is also routed through P1-1 to the AAR PCB which turns on the chart recorder automatically in response to an alarm.

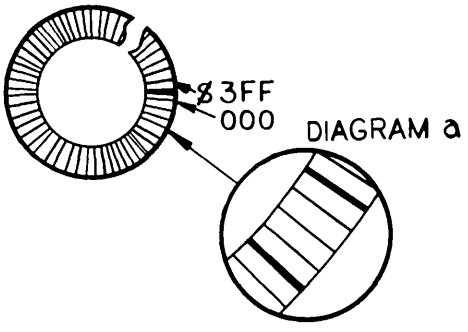
3-8. Display PCB Circuits (801904). This circuit, shown in Figure 6-3, produces a lighted digital display of the patient heart-rate in beats per minute. It also produces a flashing marker on the "R" wave which is synchronous with each beat.

U15, on the Systole Processor PCB, generates multiplexed BCD data which is fed to decoder U1 and digit drivers Q1-Q3 on the Display PCB. U1 decodes data for each digit. This pulls the appropriate segments of the LED display down through internal current-limiting resistors, while the common anodes of that digit are supplied by the appropriate driver. Each digit is strobed "on" for approximately 3.5 ms, in turn. Due to the persistance of vision of the human eye, this multiplexing process is not discernible. Q4 and Q5 serve to blank leading zeroes from the display. Q6 activates the decimal point of the leftmost display which serves as the visual systole or QRS indicator. The high currents, present in the display segments, are returned through a path separate from that used for the ALARM LIMIT resistors (see the Systole Processor section for a discussion of ALARM LIMIT circuits).

3-9. No-Fade PCB Circuits (800159). The No-Fade PCB consists of an A/D converter, a digital memory, two D/A converters, and a sawtooth generator, along with various peripheral circuits related to these functions. See Figure 6-4 for the schematic diagram and Figure 3-6 for the functional block diagram.

Refer to Diagram A and a. The heart of the system is the digital memory, a 1024 x 9 CMOS RAM (U15, U16, and U29), organized as a ring-store. The ring is addressed by a free-running counter string (U23, U24, and U17), and driven by a 2x clock, U19A. The memory addressing timing marks are shown as the bold lines of Diagram a, dividing the ring into an address space of 1024 segments, or addresses 0 to $3FF in hexadecimal notation. The fast clock generates timing signals, shown as lighter lines in Diagram a, used for synchronizing other circuits which are discussed later. The address counter makes one sweep around the ring in approximately 5ms.

DIAGRAM A



Refer to Diagram B, C and D. A second counter string in the ADC counter, comprised of U25, U26, and U27, is driven by the same 2x clock referred to above. This string is normally 1025 segments long, so that

in one 5ms sweep around the ring (represented by the spiral arrows in Diagram B, C and D) it overlaps its own tail by one segment. This starts the next sweep one address further around the ring, as shown in Diagram B. For clarity the fine lines are not shown in these figures.

A. A/D Converter. RN1, an R-2R ladder network, converts binary data from the ADC counter into analog form. This analog voltage, filtered by C25, is compared to the ECG waveform, from P1-3, by U4. When the two signals match, U4 latches the counter data into the ADC buffer, U21, by pulling the data input of U11B low. The data in U21 is an 8-bit binary representation of the ECG signal - a "snapshot" taken during the 5ms sweep.

The ADC counter continues until the ring has been swept. The data held in U21 is then transferred into the RAM at the location indicated by the address counter, shown shaded in Diagram B, C and D. If a sync signal from the Systole Processor is present on P1-25, the ninth bit of the RAM word in U29 will also be set. Thus, every 5ms a RAM word is loaded with data. The location of this word progresses clockwise around the ring.

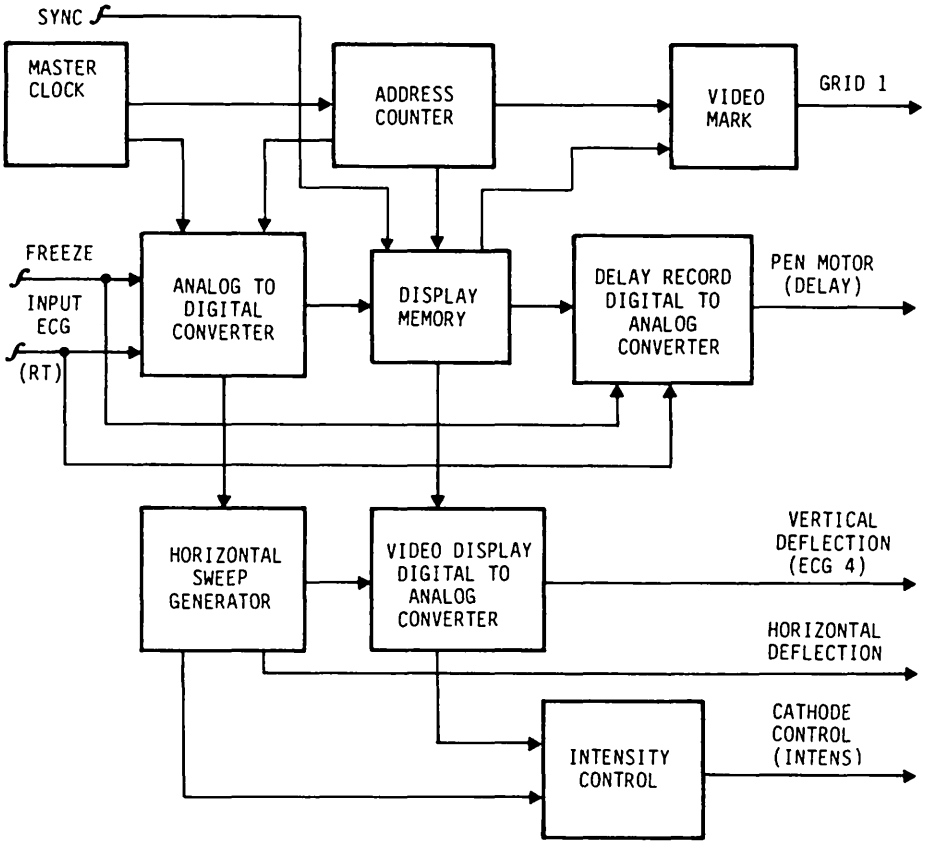
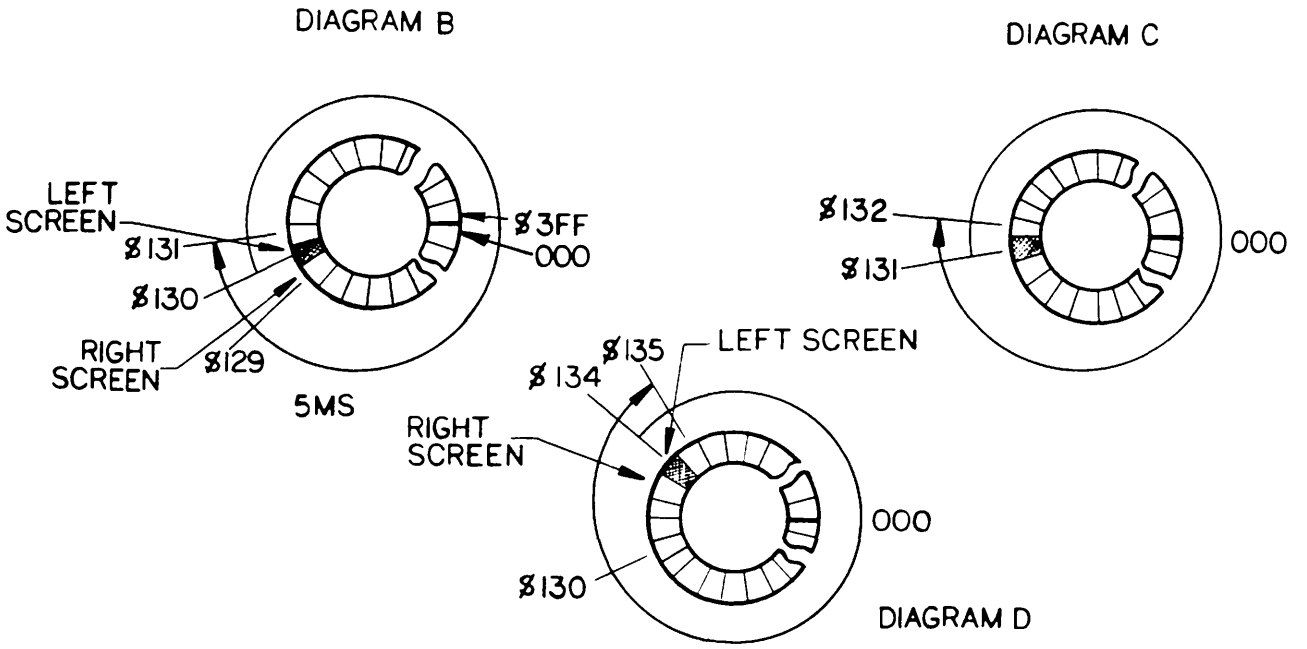


FIGURE 3-6. NO-FADE BLOCK DIAGRAM



U4 is preceded by an anti-aliasing, low-pass filter. This filter ensures that the 5ms sampling rate will be sufficiently greater than the highest frequency component of the signal, preventing alias distortion of the sampled signal. CR4 and 5 limit the magnitude of the signal to the comparator, preventing the ADC counter from "wrapping around" in response to large input signals.

B. Sawtooth Generator. Flip-flop U11A is switched once with every sweep of the ring-store by the ADC counter. The output of this flip-flop is integrated by U7B, producing a triangular wave. U18A and B control gate U6B, passing every other negative-going portion of the triangular wave. This produces a sawtooth waveform, which ramps from 2.5V to -2.5V every fourth sweep of the ADC counter.

This sawtooth waveform forms the horizontal sweep for the CRT display, sweeping from left to right. Referring to Diagram B, we have the sweep which starts, for example, at RAM location $130 and displays that data on the left side of the CRT, then continues around the ring to display the data in location $129, on the right side. Location $130 is then overwritten with the data from the latest conversion and the sweep begins again from location $131 as shown in Diagram C. This sweep of the ring, and the next two, do not produce CRT drive; although, A/D conversion and RAM storage continue. The next CRT trace is produced, as shown in Diagram D, starting at location $134. The picture, displayed on the CRT, shifts to the left. New data appears on the right. The persistence of human vision prevents the viewer from discerning the blank interval.

R3, C32, and C33 form a correction network that changes the output of U7B from a perfect triangle, in order for CRT non linearities. R11 adjusts the average value of the sweep waveform, centering the trace horizontally. Linearity is adjusted by using R42 to vary the clock frequency.

U6B is gated, providing enough positive ramp to move the electron beam to the left of the screen - in preparation for the sweep.

C. D/A Conversion. As the ring-store is swept, data is continuously read from RAM by U14, an 8-bit register. This information is fed directly to U10, an 8-bit D/A converter (DAC), which reconstructs the ECG waveform, driving the vertical deflection coil of the CRT. U5A and U5B filter the DAC output and smooth the digitization steps, while R23 adjusts the vertical position of the trace.

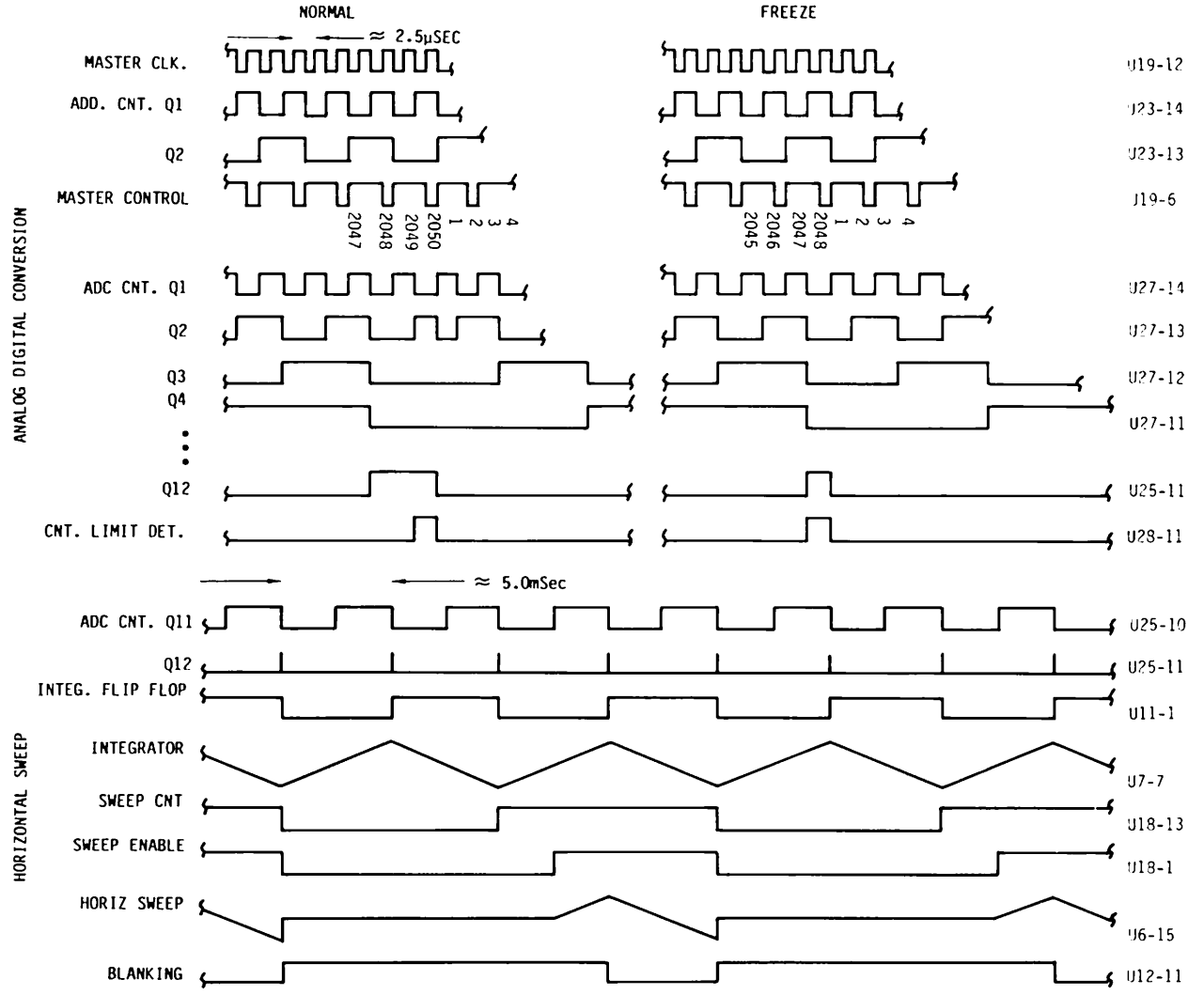


FIGURE 3-7. TIMING DIAGRAM, NO FADE

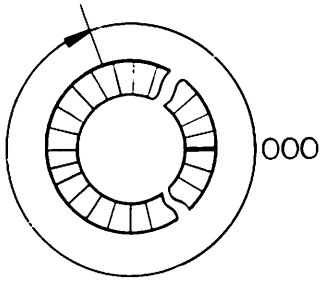
D. Blanking. The CRT actually displays only every fourth scan of the ring because the vertical deflection signal is blocked by gate U6A, except during this fourth scan. Control for U6A is generated by U12D, using the timing signals from U11A and U18A. The blanking signal from U12D also controls transitors Q2 and Q3. These transistors apply 12V to the CRT cathode, shutting off the electron beam.

E. Intensity Control. The vertical deflection signal from U5B is differentiated by U9A. U9B takes the absolute value of this slope signal and, after amplification by U8A and U8B, this signal is applied to the CRT cathode. This increases electron beam intensity, when that is lower beam is moving rapidly. R29 adjusts the amount of intensification. This feature permits an average-beam intensity that is lower than would otherwise be possible, while maintaining a readable CRT display for steep QRS waveform complexes.

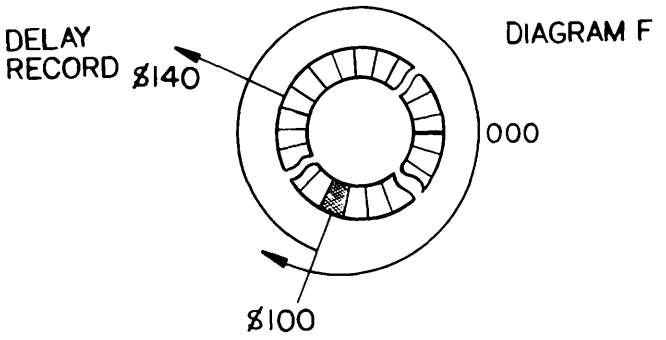
F. Sync Marker. If a sync mark has been generated by the Systole Processor during a QRS waveform complex, a group of sync. bits will be set, in appropriate RAM words, in the ring-store. As the ring is swept, U22A, U22B, and U28C generate a single pulse from a group of sync bits. This pulse is gated by the Blanking Control, in U12A, and applied to the grid of the CRT, through C11, as a 24V positive transition: This intensifies the electron beam and produces a sync marker.

G. Freeze Display. Refer to Diagram E. When the FREEZE pushbutton is depressed, an input of U12C is pulled low, shortening the length of the ADC counter string to 1024: This is the same count as the ring-store. As the ring is swept, each sweep starts at the same location and the picture remains "frozen" in place.

DIAGRAM E



H. Delayed Recording. Refer to Diagram F. As the ring is swept, data is continuously read from RAM by U14. Once each sweep, when the ADC counter reaches $40 (the 64th step), U13 latches the data from U14 and presents it to the chart recorder as the DELAY signal. The data, previously taken by U13, is placed in the ring-store in 960 sweeps, or roughly 5 seconds. Flip-flop U20B controls U13, using signals from the ADC counter. The data in U13 is fed to the R-2R network, RN2, which converts the binary data into analog form. Whenever the FREEZE pushbutton is depressed U7A filters the reconstructed signal, and U6C replaces the delayed ECG signal with the real-time ECG signal.



The sync pulse from U28C is stretched by U20A, U12B, and U28A. This network provides a sync marker on the delayed recording by disabling the outputs of U13, while coupling the stretched sync pulse to the delayed ECG signal through C20. In response to the sync pulse, the stylus scribes a vertical line on the recording.

3-10. GSI Recorder PCB Cicuits (801584). The Recorder PCB contains the circuits for stylus heating, stylus deflection, and chart drive (see Figure 6-5).

The delayed, or diagnostic, ECG signal is selected by the recorder switch and applied to the non-inverting amplifier, U4A. Signal gain is controlled by R4, which is used to set the mid-band deflection to 1cm/Volt input. C1 provides high-frequency emphasis.

The output of U4A is limited to ± 5.7V at the junction of R50, CR7, and CR8. Positive limiting is through CR7 to the +5.1V reference (the cathode of CR5). Negative limiting is through CR8 to the output of U4B (configured as a unity-gain inverting amplifier), providing the -5.1 voltage reference.

U1 furnishes power amplification to the galvanometer, which drives the stylus. As considerable power is used by the galvanometer during large stylus deflections, U1 is mounted on a heat sink. R9 supplies a bias current, derived from CR1, CR2, and R8, which centers the stylus when no signal is present. A feedback coil, within the galvanometer, produces a signal which is added to the amplified ECG signal in U1, through R3. This feedback emphasizes high-frequencies and can be adjusted using R2.

R11 through R17 form a resistive network which controls the output impedance of U1. This output impedance controls the system damping. The dc response of the circuit remains the same at all settings of R13. When the wiper of R13 is near R11, the output impedance of U1 is low, giving overdamped system response. This is caused by the back-EMF of the galvanometer coil. When the wiper is near R16, the output impedance is high, giving underdamped system response. R13 and R2 are used to produce a flat system response to signals from dc to 100Hz.

U2C, R46, and C11 create a triangular waveform, by charging and discharging C11 through R46. When C11 is discharged, the non inverting input of comparator U2C is about 6V, so U2C saturates high. C11 charges

up until its voltage causes the inverting input of U2C to exceed 6V. The output of U2C saturates low and the voltage at the non inverting terminal becomes 1.5V. C11 discharges, until its voltage becomes less than 1.5V. The op-amp switches and saturates high, which repeats the cycle at a rate of 1KHz.

The triangular wave is applied to the non inverting inputs of both U2A and U2B. The inverting input of each op-amp a recognizes variable dc level, which causes the output of each op-amp to omit a series of square pulses: The width and power content of these pulses are modulated by the dc input level.

This dc input level, supplied to comparator U2A, is provided by potentiometer R19. The pulses from U2A are applied to Q1, which supplies amplified current pulses to the recorder stylus, at J3-1 and J3-2. This causes the heating of the stylus, which is required for marking the heat-sensitive paper.

When the recorder is turned on, a quick-heat feature increases the heat level of the stylus, yielding a legible trace in approximately 1.5 seconds. Normally, when Q1 is on, the stylus has 11V across it. At turn-on, Q2 is also on while C5 remains uncharged. Q2 pulls J3, down to the negative supply, so that the stylus recognizes 23V and temporarily receives more current. C5 charges up, through R24, and turns off Q2. J3-Pin 2 returns to 0.7V and the stylus again recognizes 11V when Q1 is on.

The dc level for U2B is provided by U3, a frequency-to-voltage converter. The tachometer provides a square wave at J2, Pin 7, with a frequency that is proportional to the paper speed. At a speed of 25mm/sec, this frequency is about 84Hz. The tachometer is supplied with power at J2, Pin 5.

U3 converts the input frequency, at Pins 1 and 11, to a dc voltage of roughly 4V, at Pin 5. This voltage is applied to U2B , controlling the output pulse width.

The motor speed may be adjusted by using potentiometer R32. A built-in zener in U3 holds the voltage level of Pin 9 at 7.56V. R35 and R36 define the input crossover level at 3.78V. C8 and R39 determine the frequency-to-voltage ratio, and C9 filters the current to R39. The output of U3 is loaded by R42, at Pin 5. The modulated output pulses of U2B are amplified by Q4 and applied to the paper drive motor at J2-3.

3-11. Alarm-Activated Record Logic PCB (801546). The 801546 Alarm-Activated Record Logic PCB produces automatic operation of the chart recorder, during a preset time period, when any of the heart-rate limits is exceeded. The automatic recording circuit uses the delayed ECG signal from the No-Fade circuit, and retrieves ECG information from the instant of the alarm violation. An additional recording period is started, if another alarm violation occurs after the previous recording period has ended. However, this period is not extended by any additional alarm violations occuring during the recording period. Recording may be stopped and the timer reset by turning the recorder switch to the OFF position.

Refer to schematic diagram, Figure 6-6. A regulated ±12Vdc supply comes directly from the Low-Voltage Power Supply, and is filtered by C1, C7 and C8. Additional regulation and filtering is provided by U3 and C2. When an alarm limit is exceeded, the output of U3A or U3C, on the Systole Processor, sets Pin 4 of the AAR PCB to -12V. This ALARM signal is filtered by C10 and sent to the Schmidt trigger circuit, U2B. This lowers the voltage on the B input of the one-shot multivibrator, U1A. U1A time is set by R3 and C6 at approximately 680 milliseconds. During this time the pin 6 output of U1A sets pin 13 of U1B high, allowing U1B to be triggered U1A. Transistors Q1 - Q4 applies power to the chart recorder for 18 seconds (set by R13 and C4).

If the recorder switch is moved from the AUTO position, current will cease to flow from the -12V recorder input through CR3. Without recorder current flow, a reverse bias will appear across CR3 and R16. This turns the output of comparator U2A high and allows R20 to reset timer U1B. C9 will filter any momentary current lapses through CR3. These may occur during large pen excursions of the recorder. R4, C5, and CR1 hold U1A reset during power-up.

3-12. Power Supply Assembly Circuits (800112). The Low-Voltage Power Supply/Deflection Amp PCB (Figure 6-7) produces +5V, +12V, and -12V for the ECG Monitor and amplification for the horizontal and vertical deflection signals of the CRT. The High-Voltage PCB, is a separate PCB that combines with the Low-Voltage/Deflection Amp PCB to form the Power Supply Assembly.

A. Low-Voltage Power Supply/Deflection Amp PCB (801568). See Figure 6-8. U1 is a pulse-width modulating circuit, containing an internal oscillator and complementary drivers, which operate power FETs Q1, Q2, Q7, and Q8. R26 and C1 determine the oscillator frequency, while R27 sets the deadtime: While this is occurring, all of the FETs are off. R1 supplies current to the gate drivers at Pins 11 and 14. Ferrite beads L1-L4 prevent high-frequency oscillations within the FETS.

Q1 and Q2 form a push-pull drive for the primary of transformer T1 supplied directly from +V unregulated power, alternately pulling each leg of the winding to ground. This drive generates a square wave of current through the primary of T1, producing a square wave in the secondary. This square wave is rectified, filtered, and regulated, providing operating power for the Monitor. When Q2 turns off, CR2 limits the positive voltage spike produced by the energy stored in T1. CR19 clamps the negative spike to ground. On the opposite phase of the square wave, CR2 and CR19 reverse roles, limiting and clamping the Q1 turns off.

Q7 and Q8 form a similar push-pull drive for T2. This generates the preamp drive from the 12V power regulated by U6. R30 and C23 suppress ringing on the preamp drive signal, while R27 and C11 decouple the preamp drive from the noise generated within the deflection amps.

CR4 and CR5 form a full-wave rectifier, supplying the 5V regulator, U3. C3 and C4 provide filtering and suppress oscillations in the

voltage regulator. Similarly, CR8 and CR9 supply the 12V regulator, U5, providing the 12V power distributed to the reset of the monitor. CR6 and CR7 supply -12V to the regulator, U4, through a two-stage filter formed by R2, R3, C5, and C14.

A half-wave rectifer, formed by CR10 and filtered by C7, supplies the -56V zener-diode regulator, CR11. This voltage produces a grid bias for the CRT. The intensity of the CRT is adjusted by using R6.

B. Deflection Amplifiers. The horizontal sweep signal at Pin 22, ramps from +2.5V to -2.5V at a rate of 50 times a second. Op-amp U9 amplifies that signal, using a "totem-pole" output stage (Q11 and Q12), providing a current ramp to the CRT horizontal deflection coil, connected between J1, Pin 1 and J1, Pin 2. Q11 produces output current on the positive portion of the ramp, while Q12 does the same on the negative portion. The fraction of the P1, Pin 22, voltage signal that's applied to the non inverting input of U9, will depend upon the setting of the gain potentiometer, R16.

The reconstructed ECG wave from the No-Fade circuit arrives at P1, Pin 21, to receive power amplification and application to the vertical deflection coils of the CRT. This ECG signal represents a spectrum about which is 1000 times greater in frequency than the original. This occurs because the displayed waveforms cover a period of about 5 seconds, although they are horizontally swept once each 5ms.

The vertical deflection driver consists of op-amp U7, hybrid-current amplifier U8, and an output "totem-pole" stage, formed by Q9 and Q10. A fraction of the incoming ECG signal, adjusted by using R10, is applied to the non inverting input of U7. The current amplifier, U8, is used to provide a high base drive to Q9 and Q10, achieving fast slew rates.

Most of the deflection coil currents are produced through Q9 and Q10. The output currents from these transistors are routed through vertical deflection coil, connected between J1, Pin 3, and J1, Pin 4.

C. High-Voltage PCB Circuits (800854). The High-Voltage PCB supplies +9KVdc to the CRT anode and +400Vdc to the CRT beam, accelerating the grid. The circuit, shown in Figure 6-9, uses a flyback transformer, controlled by an NE555 IC timer with voltage feedback for output calibration and load regulation.

The timers output, U1, Pin 3, is controlled by the repeated charging and discharging of capacitor C2. The charging state of C2 corresponds with a high output of +12V on U1, Pin 3; a steady or discharging state corresponds to a low output (0V). Two voltage comparators in the timer sense the voltage on C2, through Pins 2 & 6. The comparators gate an internal switch on the NE555 IC, between Pin 7 and ground. This turns the switch on, when the C2 voltage charges above +8V, and turns it off, when the C2 voltage discharges below +4V.

When the switch is off, C2 receives some charging current from the +12V supply through R3 and CR3. This current serves to start up the supply, after which most of the charging current is provided from the feedback loop through R14.

When the switch is on, all charging current is shunted through Pin 7 to ground and C2 charging stops. A potential discharge path, through R4, Q1, and CR2, is formed. Flyback action in the T1 secondary is initiated at this time and the current flow, through CR5, changes to -0.7V at T1-6. This holds Q1 off, through CR1. At the completion of flyback (approximately 10ms), Q1 turns on, allowing C2 to discharge. R4 is adjusted to provide approximately of 15ms of discharge time. This insures that the oscillations in T1 are completely clamped before the next charge cycle is started.

The output of U1, Pin 3, is connected, through R5, L3, and L4, to the gates of two parallel, N-channel, enhancement mode V FETS (Q2 and Q3).

These transistors switch on, when Pin 3 goes high, and off, when Pin 3 goes low. While Q2 and Q3 are conducting, the current in the primary winding of T1 linearly increases, storing energy in the transformer core. When Q2 and Q3 are turned off, the magnetic field collapses and the energy, stored in the core, is released to the secondary.This results in a peak voltage of approximately +1200V at T1, Pin 4. This voltage is passed through a X8 voltage multiplier (M1), where it is rectified to dc, filtered, and multiplied to +9KVdc. T1, Pin 5, produces a peak voltage of approximately +650V. This is rectified by diode CR8, filtered by capacitor C6, and regulated to +400Vdc by zener diodes CR6 and CR7. These voltages are fed to the CRT.

The M1 sensing output produces a voltage, which is equal to V-out divided by 1000 or approximately +9V, to the feedback amplifier, U2B. This voltage is passed through an inverting amplifier stage (with a gain that can be adjusted for output callibration, by using R11).

The output of U2B is subtracted, by R12 and R13, from the Q4 zener voltage, which is approximately +6.2Vdc. The feedback loop tries to adjust the output of U2B, to a voltage which is approximately equal to the negative of Q4's zener voltage. Variances from this relationship are integrated in U2A and applied as a feedback-charging current to C2, through CR9 and R14. The feedback current varies the C2 charge time, adjusting the on time of Q2 and Q3, until the proper output voltage is achieved. A positive voltage shift, at the output of U2A, will decrease the charging time of C2. This decreases the on time of Q2 and Q3, resulting in less energy being stored, in T1 core, per cycle. The end result is a lower output voltage.

3-13. Monitor Charger PCB Circuits (800157). The Monitor Charger PCB converts line power to +15Vdc. This converted voltage is used by the Monitor and the charging of the battery. This +15Vdc is also used for automatic switching to battery power when line power is un-

available, and in circuits which drive a meter indicating the battery condition and for an LED which indicates when the battery is on charge from the line power supply. (See Figure 6-10.)

The power line connects directly to the Charger PCB, through connector J1. After passing through fuse F2 , the line is led off the PCB to a power transformer which is located in the Monitor case. Low-voltage AC is returned, from the transformer secondary, to two full-wave rectifiers.

CR3 and CR4 provide unregulated dc power, filtered by C1, which operates the Monitor. CR5 and 6 operate relay K1, pulling its wiper to the normally open (NO) position, whenever line power is available. C3 filters the power to the relay, but is small enough in value to permit rapid transfer to battery power, when the AC power line is unplugged. C1 maintains Monitor operation during the transfer to battery operation.

C2 supplies charging power to the battery, and limits the charging current. Diode bridge CR1 passes positive half-cycles to the battery, while shunting negative half-cycles to ground. Charging current flows through R2 producing a bias voltage. This turns on Q1 and illuminates the BATT CHG LED on the front panel. The battery voltage drives current through zener diode CR2, R3, R4, and the BATT LEVEL meter, on the front panel.

This PCB produces all of the Defibrillator control and logic features. It includes the stored energy controls and test-load energy controls, the digital display drive, and the the dc-to-HVdc converter required to charge the 36μf Defibrillator energy storage capacitor. The essentials of the Defibrillator logic are implemented by U1, a custom microcomputer and analog to digital (A/D) converter IC.

3-14. DC DEFIBRILLATOR - CIRCUIT DESCRIPTION

Paragraphs 3-14 through 3-16 provide the LIFEPAK 6s DC Defibrillator circuit description. The interconnect wiring diagram presented in Section 6 provides the complete interconnection data for the sub-assemblies which composes the LIFEPAK 6s DC Defibrillator.

3-15. Main Defilbrillator PCB (801820).

This PCB produces all of the Defibrillator control and logic features. It includes the stored energy controls and test-load energy controls, the digital display drive, and the dc-to-HVdc converter required to charge the 36µf Defibrillator energy storage capacitor. The essentials of the Defibrillator logic are implemented by U1, a custom microcomputer and analog to digital (A/D) converter IC. Figure 6-14 is a schematic of the Main Defib PCB.

A. Power ON/OFF Control. The on/off functions are controlled by S2, the front panel POWER switch. When depressed, this switch, applies +12V power, supplied by the charger, to the Defibrillator logic and control circuits. Note that +12 volt power is always applied, through fuse F1, to flyback transformer T1, and through fuse F3, to the Transfer Relay Assembly. The power-on reset of U1 is controlled by C20 and pull-up resistor within U1 (T_C = 100ms). U5C controls a reset, in the event of a momentary power loss (e.g. switching from AC to battery power). A +5Vdc supply, for the microcomputer and the available energy display, is produced by U2 (a power op-amp) and U4 (a +5.0V reference).

B. Charge Operation. After the delivered energy, in joules, has been selected, using switch S1 on the front panel, charging of the energy storage capacitor C1 can be initiated. This is accomplished by depressing S3, the front panel CHARGE switch, or the PUSH-TO-CHARGE thumbswitch on the external Apex paddle. Either action provides a logic low. This is applied, through comparator U6B to microcomputer U1 at pin 16. The input sets two flags within U1, a "NO-DUMP" and a "CHARGE".

Setting of the "NO DUMP" and "CHARGE" flags results in operation of the dump relay. This is through Q12 (part of the Transfer Relay Assembly 800240). It also results in the activation of oscillator U8 (a dc to high-voltage dc converter) through Q19 after a delay of 64ms. Operation of the dump relay removes the effect of the 100K, 15W dump load resistor, R1, connected across the energy storage capacitor. This dump load is normally applied across the energy storage capacitor to insure a safe and discharged state. It can remove almost all stored energy within 20 seconds. An active converter oscillator produces a high-voltage dc current thru J5 and the Transfer Relay, storing energy, at the rate of 40 joules per second, in energy storage capacitor C1, the return path is through both a second transfer relay contact and the waveshaping inductor, L1, to ground on the Defibrillator Main PCB. During charge, an integrated 1Hz oscillator, within U1, produces flashing on the front panel CHARGE lamp and the paddle CHARGE LED via Q10 and Q8.

U1 monitors the progress of energy storage via a voltage divider. This voltage divider is formed by R1 on the Main Defibrillator PCB, and a resistor (within RN1) which has been selected by S1. When the voltage divider output, which is buffered by U7B, reaches a voltage level of 3.82V at U1 Pin 23 the "CHARGE" flag is cleared and a "READY" flag is set within U1. Each resistance value, within the RN1 network, has been chosen so that 3.82V is produced whenever it is used by the voltage divider when the voltage at J5 corresponds to the desired energy level. A set READY flag produces steadily illuminated AVAILABLE ENERGY and CHARGE indicators. The instant a full charge is attained, the timer, within U1, is started. If the operator takes no further action, the READY flag will clear when the timer has counted 64 seconds. With a clear "READY" flag, transfer is inhibited, extinguishing the CHARGE indicators and the AVAILABLE ENERGY display.

C. Energy Range Interlocks. When the internal paddles are connected, the energy range interlocks (see Figure 3-8) prevent any charging exceeding 50 joules. The normally grounded terminations of resistor network RN1 on the control panel are divided into two common terminations 5 to 50 joules and 100 joules or higher. These terminations are routed through the Main Defibrillator PCB using J1 (Pins 7 and 6), to the paddle connector. At this point, each is grounded to

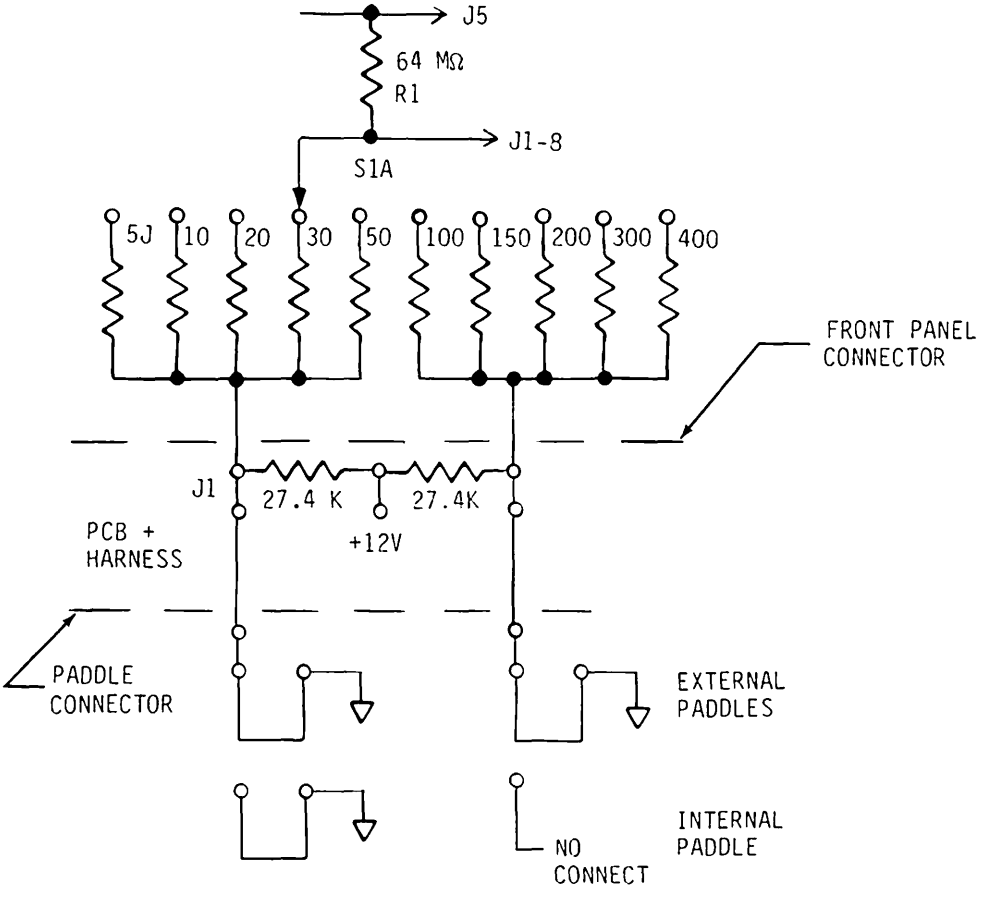


FIGURE 3-8. PADDLE ENERGY INTERLOCKS RANGE

enable the selected energy level. If no ground is present, either R56 or R13 insures that U1, Pin 23, is above 4.32V, inhibiting the charge.

D. DC-to-High-Voltage DC Conversion. Oscillator U8, switching transistor Q24, and flyback transformer T1 combine to form the essentials of the dc-dc converter. A low output at U1, Pin 40, starts the converter. Q20 insures that the dump relay drive is active before allowing any converter output. This withholds any high-voltage dc output from the dump load.

The converter operates at a varying frequency of 10-20KHz. Each converter cycle is started by a timeing circuit. The timer is formed by C5, charging thru R62 (CHARGE TIME ADJUST), and by the activation of Q23 and Q24, driven from U8, Pin 3. During this period, the T1 primary current rises from zero towards the transformer saturation level. As C5 reaches 5V, (approximately 60ms) U8, Pin 3, goes low, turning Q23 and Q24 off. This low output also turns on Q21 and Q22 causing C19, which was charged during the ON cycle, to apply a negative base drive to Q24. This accelerates the speed of turn off. The subsequent collapse of the T1 field induces a high positive voltage in T1, terminal 6, and a large positive voltage at terminals 2,4). The energy storage capacitor voltage determines the magnitude of this voltage and the subsequent time (about 20ms) to transfer the energy, stored in the field, through the high-voltage rectifier, CR1, to the storage capacitor. This causes the pitch of the converter to increase during charge.

When T1 secondary current is flowing, it serves as a timing circuit sensor and diode CR13 is forward biased. This insures that T1 is completely discharged before the next cycle begins. When secondary current ceases, the CR13 zener voltage (3.3V) is reestablished. This activates a HOLD OFF timer, formed by C5 discharging through Q27 and R61 (waveform adjust). The HOLD OFF period (about 5ms) permits the transformer primary (Pin 2) to ring , a natural tendency, when zero volts is reached, but before Q24 is reactivated, to start the next cycle. This contributes to an efficient Q24 turn on transition.

E. Capacitor Overcharge Protection. Overcharge protection is provided by comparator U5D. Should some element of the energy charging circuit fail to properly end the charge and cause the storage capacitor voltage to reach 5750V, U5D will turn on on Q21 and Q22, preventing any further converter output. This circuit latches until the capacitor is discharged. When the power is switched ON, Q27 assures that the latch is reset.

F. Low Battery Compensation. Compensation for a nearly discharged battery is provided by comparator U7D. As the battery voltage decreases to 9 volts, converter switching noise will begin to toggle this comparator. This causes a reduction in the ON PERIOD discussed previously, and results in a lower converter current comsumption and power output. As a result, the charge time to full energy

increases well beyond 10 seconds. This increase in charge time usually occurs after 25-30 completed energy charges have been obtained from a fully-charged battery. Low battery compensation allows Defibrillator operation without reverse biasing or possible damage to the battery cells.

G. Energy Range Reselection. If the energy select switch is turned while any charge still exists on the energy storage capacitor, the Defibrillator will revert to the POWER-UP standby state. This discharges all capacitor energy and stops any further charging action. Energy select switch action will momentarily result in a no voltage divider effect (discussed previously). This occurs because S1 is a break-before-make type of switch. At this point the only limit on the voltage at J1, Pin 8, is furnished by VR2 (±18V). Any voltage greater than 4.32V, at Pin 23 of U1, is interpreted as an energy select switch action, resetting the NO DUMP and the CHARGE or READY flags to their power-up state.

H. Capacitor Charge Refresh. While the unit is fully charged and READY, U1 maintains the storage capacitor energy level. U1 can also activate the dc-HVdc converter, at one second intervals (±2.5%). This occurs only when the voltage, at Pin 23, indicates refresh is required; however, the power output of the converter is reduced (from 40W to approximately 12V). This is accomplished by turning on Q28, which increases the "HOLD OFF" period (previously discussed in the paragraph on dc-to-HVdc conversion).

I. Discharge (Defibrillation). A discharge of current from the Defibrillator a test load is accomplished by depressing both external paddle discharge buttons, simultaneously, or by depressing the front panel INTERNAL PADDLE DISCHG button. Either action will ground J2, Pin 3. An interlock in the paddle connector confines the use of the front panel control button to internal paddles only. If the "READY" flag is set in the microcomputer, U1, because the capacitor is fully charged, U1 momentarily (125ms) energizes the Transfer Relay solenoid through Q1. This isolates the energy storage capacitor, C1, and the waveshaping inductor, L1, from all other circuits and places them in series across the paddles. The microcomputer, U1, will recognize the action of the discharge buttons, only after they have been depressed for 125ms. This precludes a nuisance discharge. A malfunction in the microcomputer, U1, cannot spontaneously operate the Transfer Relay unless the discharge buttons are depressed. A separate relay control path (CR6, Q9, Q5, Q4, and Q2) from J2, Pin 3 to the Transfer Relay drive output (J3, Pin 7), has been included to prevent such an occurrance.

J. Discharge (Synchronized Cardioversion). Synchronized Cardioversion (SYNC) can be selected or turned off by depressing the SYNC button. The Defibrillator logic resets SYNC when power is turned on. SYNC can only be selected when the Defibrillator is connected to an operational LP6s Monitor unit. The Monitor holds the voltage level near 0V, except during the 10ms, 5V SYNC pulses. The Main Defibrillator PCB tests for this valid interface by sending current (turning the U5A output off) through the pull-up resistor, R53, into the interface for at least 125ms. The comparator, U5B,

monitors the interface for a voltage level of less than 2.5V then either the PADDLES mode is selected, or the QRS SYNC pulse is transmitted from the Monitor. Consequently, anytime the interface exceeds 25V for 125ms, the SYNC signal is inhibited (e.g. when the ECG select switch is turned to the PADDLES position). The pull-up resistor, R53, is also enabled whenever the SYNC mode is active, a condition which provides the Monitor with the indication that the SYNC marker should be shown on the CRT.

Whenever SYNC is active, the microcomputer, U1, illuminates the SYNC indicator lamp. However, U1 also extinguishes this lamp for 125ms following the receipt of each SYNC pulse. This is an indication that the SYNC signal is being received.

Delivery of energy to the PADDLES is synchronized (within 20ms) with the 5V, 6.2ms QRS SYNC pulse that is received from the Monitor/ Recorder. Depression of the paddle discharge switches or the front panel INTNL PADDLE DISCHG switch, while the microcomputer, U1, READY Flag is set, will immediately terminate the REFRESH function of starage Capacitor C1. This action insures that the dc-HVdc converter is not active the moment a triggering sync pulse is received. After the discharge buttons have been depressed for 125ms, microcomputer, U1, begins to monitor for the sync pulse. This produces a synchronized operation of the Transfer Relay drive. If the discharge buttons are released during a transfer, the arm-timing capacitor, C22, insures that the transfer is not stopped. If the discharge buttons are released before a synchronized discharge, the refresh condition is reinstated.

If the discharge buttons are held without receipt of a QRS sync pulse and either the 64-second timer expires, or the storage capacitor energy decays by 10%, the display and charge lamp will extinguish and transfer of energy will be inhibited.

K. Available Energy Display. The microcomputer, U1, provides a redundant measurement and display to the user of the energy within the energy storage capacitor. This display is active when the unit is charging or fully charged and ready. The energy is sensed by R2, 64 megohm resistor. A separate buffer amplifier (U7C), calibration pot (R24) and A/D input (U1 pin 24) support this function as well. Based on this voltage signal, U1 calculates the energy which would be delivered into a load of 50 OHMS at the Defibrillator paddles. U1 continuously multiplexes the 3-digit AVAILABLE ENERGY DISPLAY at a 500Hz rate, through Q15, Q16, and Q17. (Each digit of the display is "on" for 2ms). Data for the display is provided by U1 thru "PORT A BITS 0-3". When the display is inactive, it is blank display. U1 always activates the "available energy legend" through Q13 whenever this information is being displayed.

Logic within U1 causes the value shown within the display to be updated at 1 second intervals providing an intelligible reading at all times. (The display updates at 1/4 second intervals in the "calibration" mode - see calibration and adjustment Section 4). The logic within U1 also provides "bracketing" of the displayed values so that selected energy values are displayed if the measured

energy is within 15% or 4 joules of the selectable value. If the measured energy is outside this range, the measured energy value is displayed. Since the +5 volt reference is used by the A/D converter within U1 to convert both the capacitor charging feedback signal (AN1) and the stored energy signal (AN0) an unnoticed "out of tolerance" condition could affect both defibrillator features. To prevent this happening, the redundant +2.5V reference (U3) must be referenced properly, or U1 will deactivate the display of available energy as a signal to the user that the defibrillator requires service.

L. Test Load Display. The microcomputer, U1, also provides a defibrillator self-test feature which allows the user to test for proper Defibrillator operation at energy selections of 100J and at the maximum energy setting of 360J (or 400J). This tests not only the capacitor charging circuits, but tests the discharge switches, transfer relay and driver transistors and also the paddle wiring and connectors.

With a given discharge into the test load, the input from the test load assembly to the main board, has the waveform shown in Figure 4-7. This signal, filtered by C23 and C26, buffered by U7A and U1, provides a "track and hold" action to determine the peak test load current. If this value is within limits, the associated energy will be displayed within the energy previously discussed along with illumination of the "TEST LOAD" via Q14. The "TEST LOAD" display will persist for 4 seconds unless immediate recharge is selected by the user. "Bars" are displayed if an out of tolerance signal is detected.

The microcomputer, U1, turns off the test load display for all selected energy ranges other than 100J, and 360J; also, the display is turned off when the Defibrillator is not discharged into the test load. The energy select switch S1-B provides a logic low to U1 input PD6 whenever 100J or full energy is selected, thus enabling the test load display. In order to prevent any test load reading when the test load is not being used, U1 only enables the display if a current signal greater than that associated with a 50 joule delivery is detected.

The test load feature provided by the main board cannot be used to test another Defibrillator. This is because the microcomputer, U1, monitors the test load signal only during the 27ms period immediately following activation of the transfer relay. Thus if the relay is too slow, (of concern for synchronized cardioversion) or if some other defibrillator is discharged into the test load, the microcomputer, U1, will not recognize the test load signal.

M. Watchdog Circuit. Timer U9 provides a redundant check on the microcomputer, U1. In normal operation, U1 provides a 1KHz, 1% duty-cycle signal which maintains U9 in the "SET" state. U1 can generate this signal only if internal self tests are satisfied. The only conditions (besides failure) when this signal is not present are during power-up, self test and during the 27ms test load "track and hold" period. U9 is capable of detecting a "stuck high" or

"stuck low" in 1ms and 100ms respectively. In the event of a microcomputer failure, U9 disables all U1 outputs resulting in extinguished indicators, disposal of any stored energy (into an internal load) and inactive transfer relay. DS4, an on-board LED is illuminated to aid in servicing (this LED is on momentarily at power-up). In the unlikely event that the microcomputer, U1, has not failed but has been affected by some external EMI, the condition may be corrected by cycling the power or turning the charge switch on and off several times. This is accomplished by the circuit of U9 thru R55 and Q25. This circuit also prevents the unit from charging if the CHARGE switch has been accidently depressed when the power was turned on.

N. Jumpers (J10). These jumpers have been provided to allow the use of this main board in more than one product and also to calibrate the available and test load energy features. In normal LP6s operation jumper J10-3,4 should be installed to connect S1-B to microcomputer, U1, thus enabling the test load as described previously. If 360 joule operation is required, a jumper must be installed at J10-5 and 6. If 400 joule operation is required, the jumper J10-5 and 6 must be removed.

O. Battery Indicators. Two front panel battery indicators are provided. For "BATT CHG." (battery charge) status, 10V is subtracted from the battery terminal voltage (which is applied at J6-1) by zener diode CR17. The remaining potential is applied across pot R63 (battery meter cal) and the front panel battery meter "BATT LEVEL", via J1-14. This provides an indication in the green meter region for fully charged batteries and an indication at the red-green divider when approximately 20% of it's battery charge remains. A signal, provided by the charger PCA, to indicate battery charger activity, is simply routed through the main board to the front panel via J1-1.

3-16. Defib Charger PCB Circuits (800041).

The Defibrillator Charger PCB assembly 800041 is available in four voltage configurations: the standard 117VAC, 100VAC, 220VAC and 240VAC. The circuit descriptions of all four configurations are identical to the standard 117VAC circuit described below except as follows: in the 100VAC circuit the working voltages at C2 and the collectors of Q2 and Q2 are slightly lower; in the 220VAC and the 240VAC circuits the working voltages at C1 and the collectors of Q1 and Q2 are approximately double (see Figure 6-15A). The Defibrillator Charger PCB performs three functions: it converts line AC to dc for the Main Defibrillator PCB, it charges the Defibrillator battery, and it effects automatic changeover between these two alternative power supplies.

In the 117VAC voltage configuration, the 117VAC is rectified and converted to 155Vdc, which is used to generate a 25KHz square wave. 12Vdc is derived from this square wave. In the initial step of this conversion process, line AC is applied directly to a full-wave bridge, CR8. Series inductor L1 serves to block radio-frequency interference and capacitors C1 and C3 bypass power-line frequencies. The nominal no-load rectifier output across C1 and C3 is 155Vdc. The thermistor, RT1, limits the initial surge current which occurs when the unit is first connected.

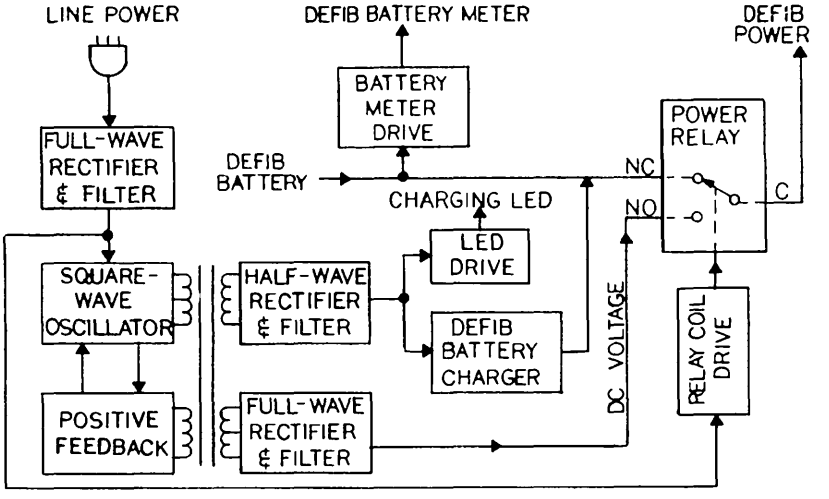


FIGURE 3-9. DEFIB CHARGER PCB BLOCK DIAGRAM

Transistors Q1, Q2, and transformer T2 are the principal elements of the square wave oscillator. By alternately conducting, Q1 and Q2 produce a 25KHz input to the T1 primary. The dc path of Q1 is from the positive lead of C3 (the voltage supply) through T1 winding 8-9, T2 primary winding 1-3, Q1 collector to emitter, R3 and back to C3 negative lead. The dc path of Q2 is T1 winding 8-7, T2 winding 4-2, Q2, collector to emitter, and R3. Positive feedback for Q1 and Q2 is provided respectively by T2 secondary windings 6-5 and 6-7.

In phase with the alternate conductions of Q1 and Q2, points T1-9 and T1-7 are alternately connected to the negative side of the +155V supply. Consequently, the 155V potential at T1-8 is alternately referenced to T1-9 and T1-7. Because of auto-transformer action, an imposed voltage across one half of T1 primary results in a voltage of equal magnitude across the other primary half. The peak voltage across the primary winding 7-9 of T1 is approximately 310V which is also the peak voltage between Q1 collector and Q2 collector. Note that C3 negative lead is not grounded and should not be inadvertently grounded during test connection.

Points 1 and 3 of the T1 secondary winding alternately swing 12V positive with respect to center tap 2. This secondary voltage is full-wave rectified in CR5. The output, filtered by L2 and C6, is +12V, appearing at the normally open contact of relay K1. CR5 is a dual Schottky diode package capable of conducting the 10 ampere load current required by the Defibrillator PCB.

When AC line voltage is applied to the bridge rectifier CR8, it is half-wave rectified by CR7 and applied to the 48Vdc operating coil of relay K1. The energized coil then causes wiper C to connect the normally open contact of K1 to J2-4 as an output to the Main Defibrillator PCB.

At startup or with no load on T1 secondary, a small transient voltage is induced in T1 winding 6-5 by flux change through T1 winding 7-9. If,

for example, this transient voltage is applied in positive sense to Q1 base, some resulting small current will flow through Q1 collector. That current, conveyed through T2 winding 1-3 will induce a voltage in winding 5-6 driving Q1 base further positive. This positive feedback cycle will cause Q1 to be forced rapidly to saturation.

As Q1 approaches saturation, its collector current becomes constant and the induction of positive voltage at T2-5 ceases. The lessening of base drive in turn reverses the collector current buildup. Thus T2 flux starts to drop, causing the voltage induced in its windings to change polarity. Q2 base becomes positive and Q2 collector current mounts rapidly from zero toward saturation. When Q2 saturates the cycle begins again.

Thus T2 flux and current oscillate and the current in the T1 primary and the induced voltage output from T1 secondary 1-3 oscillate correspondingly. Transformer T2 operates in the saturated flux density region. This fact, augmenting the sharp saturation characteristic of Q2 and Q2, generates a square wave at the transformer output. (the square waveform and relatively high frequency together give a very efficient transformer action.)

If line voltage is disconnected, the charge on smoothing capacitor C8 qhickly drains off through K1 coil, allowing rapid transfer of K1 wiper to the normally closed contact. The alternative power source, the 12V one ampere-hour battery, is connected from J1-2 to the J2-4 output terminal point.

If line voltage is applied to the relay K1, the battery is disconnected from the Defibrillator Unit and is trickle-charged. The charging current is obtained through rectification of the 24V, 20KHz output of T1 windings 1-3. This secondary waveform is applied through rectifier CR6 to a constant current source U1. The typical charger current is 100mA dc. The voltage drop generated in R5 by this current turns on Q7, which lights the BATT CHG LED on the Defibrillator control panel when the batteries are being charged.

3-16A. Charger PCB Circuitry (801505). The Charger PCB performs three functions: conversion of line AC to DC for application to the Defibrillator PCB and Monitor; charging the alternative power sources, the Monitor and Defibrillator batteries; and automatic transfer between the two power sources. The basic 220VAC and 240VAC configurations are described below. (See Figure 6-15B.)

The AC conversion involves rectification to 320Vdc (for 220VAC units), 345VAC (for 240VAC units) or 115Vdc (for 117VAC units), use of this voltage to generate a 25KHz squarewave, and recitification to 12Vdc and 17Vdc for the Defibrillator and the Monitor respectively. In the initial step, the line AC is applied directly to a full-wave bridge CR8. Filtering the bridge output, series inductor L1 serves principally to block radio frequency interference; capacitors C1 bypass power line frequencies. The nominal no-load rectifier output across C1, C3 is 320Vdc (for 220VAC units), 345Vdc (for 240VAC units) and 115Vdc (for 117VAC units). Thermistor RT1 limits the initial inrush current when the unit is first connected to the AC lines (Mains).

Transistors Q1 and Q2 an transformer T2 are principal elements of a squarewave oscillator, the transistors conducting alternately to produce a 25KHz output to transformer T1.

Q1's dc path is from the positive lead of C3 (the voltgae supply) through T1 winding (13-14), T2 primary winding (1-3), Q1, R3, and back to C3. Q2's dc path is T1 winding (13-12), T2 winding (4-2), Q1, and R3. Positive feedback for Q1 and Q2 is provided by T2 secondary windings (6-5) and (6-7).

In phase with the alternate Q1 and Q2 conduction, points T1-14 and T1-12 are alternately connected to the negative side of the +150V supply voltage. Hence, the 155V potential at T1-13 is alternately referenced to T1-14 and T1-12. By autotransformer action, an imposed voltage across half of T1 primary results in a voltage of equal magnitude across the other primary half. The peak voltgae across T1 primary winding (12-14) is therefore approximately 630V for 220VAC units, 680V for 240VAC units and 310V for 117VAC units. Note that C3 negative lead is not grounded and should not be grounded during test connection.

T1 secondary winding points 19 and 21 alternately swing 12V positive with respect to center tap 20. This secondary waveform is full-wave rectified in CR5. The output, filtered by L2 and C6, is +12V, appearing between the normally open contact of relay K1 and J2-2. CR5 is a dual Schottky diode package capable of conducting the 10A load current required by the Defibrillator PCB.

When line power is the voltage source, +12V is applied to LM317T which is adjustable. Output voltage is applied to K1 coil, holding the relay contacts in the normally open position. This allows +12V from the T1 secondary to J2 pin 4. Should line power be lost, the K1 relay goes to its normally closed position. This allows the battery to become the power source.

Output from T2 secondary point 18 is rectified and filtered by CR6 and C2. A negative bias at Q6 base turns Q6 on and lights the battery charging indicator. U1 is an adjustable regulator that controls charging current to the battery. When line power is absent, CR9 prevents battery current from reaching the regulator.

3-17. Test Load PCB Circuits (801841).

The 801841 Test Load circuit is designed to present a standard 50Ω load to the defibrillator when discharged into the test circuit. This circuit contains a current sensing transformer, T1, which produces a voltage that is proportional to the current through the test load resistor, R1, approximately 80mV/Amp. This signal is delivered to the Main Defibrillator PCB 801820 through a shielded cable and is, ultimately, used to drive the 3-digit display on the front panel. See Figure 6-16 for the schematic diagram.

MOV1 protects CR1-CR4 against any high-energy fast risetime transients which could otherwise cause a reverse-bias breakdown of one pair of the diodes before the other pair could conduct.

3-18. Energy Meter PCB Circuits (801843).

The 801843 Energy Meter PCB has a 3-digit display complemented by two legends, AVAILABLE ENERGY and TEST LOAD. It is driven by a microcomputer on the Main Defibrillator PCB Assembly. The 3 digits display operates on a +5 volt supply and are multiplexed under Main Defibrillator PCB control. An integrated circuit, U1, receives BCD data, synchronized with the multiplexing of each digit, and produces the appropriate drive to the active segments of each digit. The BAR display (out-of-tolerance test load reading) is generated when hexadecimal "C" BCD data is received. In this case, U1 produces drive to segments b,f, and g. However, U2 also prevents drive to segments b, through Q1, and f, through Q2. This results in the illumination of only segment g. The legends are not multiplexed, but are driven separately by unregulated +12V power. See Figure 6-17 for the schematic diagram.

SECTION 4
MAINTENANCE

4-1. INTRODUCTION

This section provides maintenance, servicing and calibration procedures for the LIFEPAK 6s Cardiac Care System. It includes a list of recommended test equipment and a troubleshooting guide for help in fault isolation. Troubleshooting, repair, test, calibration, and component removal should be attempted only by qualified personnel. Printed Circuit Boards (PCBs) which cannot be repaired in the field should be returned to Physio-Control for servicing.

4-2. GENERAL

Paragraphs 4-3 through 4-6 provide information applicable to both units of the system.

4-3. Warranty. The LIFEPAK 6s Cardiac Care System is warranted against all defects in parts and workmanship for a period of one year from date of delivery; patient cable and stylus for 90 days. Physio-Control will repair or replace any products which prove to be defective during the warranty period, provided proper use and maintenance procedures are followed as described in this manual.

All defective products or components must be returned to Physio-Control, or its authorized service center, with a detailed explanation of the failure. Transportation charges must be prepaid.

Service performed, other than stylus replacement, by other than Physio-Control or its authorized agents may, at the discretion of Physio-Control, be cause to void this warranty.

No other party is authorized to make other warranty, or to assume any liability for Physio-Control products. No other warranty, either implied or in writing will be recognized.

4-4. Periodic Electrical Adjustment. To insure accurate measurements, the test and calibration procedures for the ECG Monitor/Recorder and the DC Defibrillator should ideally be performed at three month intervals, but not less than semi-annually. In addition, replacement of components may necessitate adjustment of the affected circuits. These procedures can be helpful in localizing certain troubles if they exist in the system and insure the product is operating as intended.

4-5. Servicing Techniques. The following techniques should be observed when general service or repair is performed on the instrument:

WARNING

TERMINALS AND WIRES CARRYING HIGH VOLTAGES ARE EXPOSED WITH THE LIFEPAK 6s COVERS REMOVED. PRACTICE SAFE WORKING TECHNIQUES. BE CAREFUL AT ALL TIMES.

A. Before handling a PCB for repair or replacement, check for Electrostatic Sensitive Devices (ESDs) and treat accordingly (ESDs are identified on the parts lists in Section 5 with this symbol

).

B. Before removing a PCB for repair or replacement, label each lead or draw a sketch showing the location of cables and wires.

C. Use a soldering pencil with a rating of 25W. A soldering gun is usually too hot and cumbersome, which easily leads to damaged components and/or PCBs. Multilayer PCBs are especially sensitive to excessive heat.

D. Use only 60/40 solder of low melting temperature. If needed, a non-corrosive flux can be used to aid in soldering . The PCB should be thoroughly cleaned and the repaired area coated with a lacquer, varnish or plastic, afterwards. Mechanical solder suckers should not be used on multilayer PCBs.

E. A heatsink or similar device should be used in soldering semiconductor components. This also helps prevent damaging the solid state devices. Cut component leads first then unsolder and remove leads.

F. Breaks in PCB lands should be repaired by bridging with wire from pad to pad, not by laying solder across the break. The heat from the soldering iron may cause the land to dislodge from the board. DO NOT DRILL HOLES IN MULTILAYER PCBs, IT CAUSES SHORT CIRCUITS.

G. For cleaning external covers, patient cable, and the CRT face, use a mild detergent type cleaner (e.g., dishwashing liquid). Do not use alcohol, solvents, cleaning solutions or agents with ammonia. These agents may damage the surfaces of the instrument. For interior cleaning, use dry compressed air. A dry flexible paint brush can be used to dislodge dust.

CAUTION

Printed circuit boards in LIFEPAK 6s can easily be damaged beyond repair by improper handling. Plated through-holes used to connect the circuitry on two sides of the board are particularly vulnerable to damage. UNSKILLED PERSONNEL SHOULD NOT ATTEMPT TO REPAIR ANY OF LIFEPAK 6s PRINTED CIRCUIT BOARDS.

4-6. Test Equipment. Test instruments suitable for maintenance and calibration of the LIFEPAK 6s System are listed in Table 4-1. Although specific, commercially available test instruments are recommended, OTHER TEST EQUIPMENT WITH SPECIFICATIONS EQUIVALENT TO THOSE LISTED MAY BE USED.

TABLE 4-1

TEST EQUIPMENT

NOMENCLATURE	CHARACTERISTICS	MANUFACTURER
DC Power Supply	Output Voltage: 0-20 Vdc Output Current: 0-10 Amps	Deltron Model SP20-10
Oscilloscope	Bandwidth: dc, to 10mHz Vertical Sensitivity: 5mV/div to 50V/div Input Impedance: 10MΩ Sweep Range: 1 μSec/div to 1 Second/div	Tektronix Model 465 with camera.
Digital Multimeter (DMM or DVM)	Range: 0 to 1000VFS Accuracy: 0.5% of full scale on DCV and resistance ranges, 1% of reading on ACV.	Fluke 8000A with high voltage probe (2 required).
Voltmeter (VOM)	Range: 0-5KVdc (20KΩ/V) Accuracy: ±3%	Triplett 630 APLK
Energy Test Meter	Power Range: 0-1000 joules Load resistance: 50Ω ±0.5% Accuracy: ±2% of full scale for pulse width of 5ms.	Dempsey 429B, Mod #1
Stopwatch	Accuracy: ±0.25 seconds	
Variable Auto-transformer	0-140V RMS 0-240V RMS Current rating: 5A	General Radio W8MT3 (120V) Superior Electric, Type 3PN226 (230V)
Function Generator	Frequency Range: 20-120 PPM Pulse Required: Positive 0-5V 10ms	Kronhite Model 5400A
Isolation Transformer	250VA, 60Hz	Stancor GIS-250
Heart Simulator		
Test Connector	3-pin male (mini)	Molex
Extender Boards		PCC No. 800334-00 PCC No. 800336-00
Extender Cable Kit		PCC No. 802083-00
Gram Gauge	Range: 2-20 grams (Flat Tip)	Halda Dynamometer Type Gram Gauge

TABLE 4-1 (Continued)

TEST EQUIPMENT

NOMENCLATURE	CHARACTERISTICS	MANUFACTURER
Log-Linear Sweep Generator		Interstate F-27
Counter/Timer		Tektronix Model DC 504
PFC Removal Tool		PCC No. 800742
Stylus Adjustment Tool		PCC No. 801470-00
Stylus Removal/Insertion Tool		PCC No. 801513-00
Jumper Cable Block		PCC No. 201176-00

4-7. ECG MONITOR UNIT

Paragraphs 4-8 through 4-39 provide maintenance procedures for the ECG Monitor and are divided into three topics: Troubleshooting, Test and Calibration, and Major Component Removal and Installation.

Figure 4-1 provides an overall view of the ECG Monitor unit with key component locations called out.

4-8. Troubleshooting. Refer to paragraph 4-24 for Major Component Removal and Installation instructions. Troubleshooting should start with observing for obvious symptoms such as odors or discoloration from overheated components. Use Table 4-2, ECG Monitor Unit Troubleshooting Guide, to aid in the isolation of specific malfunctions.

TABLE 4-2
ECG MONITOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Unit does not function when POWER pushbutton S2 is depressed.	a. Defective fuse F1 or F2 on Charger PCB.	a. Replace if necessary. Replacing a blown fuse will often restore the unit, however, a careful check of the circuitry is in order. If fuse opens when power is applied, check for short circuit in system power supply.
	b. Battery discharged.	b. Recharge battery by plugging unit into a proper AC power source.
	c. Defective system power supply.	c. Perform Power Supply Tests, para. 4-11.
2. No luminous trace on CRT.	a. Defective CRT high voltage power supply.	a. Perform Power Supply Tests, para. 4-11.
	b. Defective CRT sweep/deflection circuits.	b. Perform CRT trace checks and adjustments, para. 4-13.
	c. Defective CRT	c. Replace CRT.

TABLE 4-2 (Continued)
ECG MONITOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
3. Interference on CRT trace when using patient cable as ECG pick-up.	a. Poor electrode contact or placement. b. Defective patient cable. c. Defective common mode rejection circuit in preamplifier.	a. Inspect electrode faces and reposition on patient. b. Replace patient cable. c. Perform Preamplifier Tests, para. 4-12.
4. Excessive 50Hz or 60 Hz interference on CRT when using external Paddles as ECG pick-up.	a. Defective Paddles. b. Defective transfer relay. c. Defective slide contacts. d. Defective pre-amp.	a. Replace Paddles. b. Check transfer relay contacts for continuity (see DC Defibrillator troubleshooting). c. Check slide contacts on both modules. d. Check notch filter.
5. No ECG signal on Cardioscope when using patient cable, but 1mV display is available.	a. Defective patient cable. b. Defective pre-amplifier circuits.	a. Check continuity of patient cable, or replace. b. Perform Preamplifier Tests, para. 4-12.
6. No ECG signal on Cardioscope when using Paddles for ECG pickup, but 1mV display is available.	a. Defective Paddles. b. Defective transfer relay. c. Defective LEAD SELECT switch.	a. Replace Paddles. b. Replace transfer relay. c. Replace switch.
7. Fuzzy or dim CRT trace.	a. Misadjusted CRT operating voltages. Poor connection at CRT connector.	a. Perform CRT adjustments, para. 4-13. Clean CRT contact pins.

TABLE 4-2 (Continued)
ECG MONITOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
8. Recorder does not run on AUTO,DELAY or DIAG.	a. Faulty Power Supply.	Check CRT on or not? Perform Power Supply Test. para 4-11.
	b. Faulty Recorder Switch.	Contacts accessible on back of front panel. See Schematic for Control PFC (801548).
	c. Faulty Control PFC connection(s) (801548).	Check flex installation and connectors on Main PFC (801521) and GSI Recorder PCB (801584).
	d. Faulty GSI Recorder PCB (801584).	Test GSI Recorder PCB (801584) para.4-22.
9. Recorder does not run on AUTO.	a. Faulty Recorder Switch.	see 8 b.
	b. Faulty Control PFC connection(s) (801548).	see 8 c.
	c. Faulty rate alarm controls.	Check audible alarm. Check heart rate display.
	d. Faulty Systole Processor PCB 801445.	Perform Systole Processor Tests. para.4-14. If OK see (f).
	e. No alarm signal (-12v approx).	Check P1-pin 1 on Systole Processor PCB 801445 (-12vdc).
	f. Faulty AAR Logic PCB 801546.	
10. Recorder does not run on DELAY.	a. Faulty Recorder Switch.	See 8 b.
	b. Faulty Control PFC connection(s) (801548).	See 8 c.
11. Recorder does not run on DIAG.	See 10a, & b.	

TABLE 4-2 (Continued)
ECG MONITOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
12. Recorder motor runs but no trace on paper.	a. Stylus HEAT set too low.	a. Perform Recorder stylus replacement or adjustment in Section 2.
	b. Stylus bent or maladjusted.	b. Same as item a above.
	c. Defective heat circuit.	c. Check stylus heat circuit.
13. Recorder runs but stylus stays deflected to one side or does not respond and stays at center.	a. Defective pen drive motor.	a. Replace pen drive motor.
	b. Defective drive circuit.	b. Check pen motor drive circuit. (Schematic 801584)
	c. Defective No-fade.	c. Check U6 (output gate).
14. No deflection when 1mV switch depressed, but normal trace on CRT when signal applied to patient cable.	a. Defective switch.	a. Replace switch.
	b. Defective voltage divider in calibrate circuit.	b. Check voltage divider on Systole Processor PCB. (Schematic 801445)
15. No signal on CRT or Recorder when signal is applied. Normal baseline trace on CRT.	a. Defective pre-amplifier circuit.	a. Perform Preamplifier Tests, para. 4-12.
	b. Defective no-fade circuit.	b. Perform no-fade circuit checks, para. 4-13.
16. No signal on CRT or Recorder when ECG signal is applied at the PATIENT CONN.	a. ECG SELECT switch in wrong position	Correct selection.
	b. ECG SIZE control improperly set	Correct setting.
	c. Bad connection at the PATIENT CONN.	Change or clean connector.
	d. Faulty signal path through Preamp PCB (800101) and Systole Processor PCB (801445)	Check signal at the ECG OUT connection on rear panel of monitor. If OK see 18. If not see 17.

TABLE 4-2 (Continued)
ECG MONITOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
17. No signal through Preamp PCB (800101) (801873) and Systole Processor PCB (801445).	a. ECG Preamp defective.	Perform ECG Preamp Test Procedure.
	b. Systole Processor defective.	Perform Systole Processor Test Procedure.
18. No signal through No-Fade PCB (800159). Low Voltage Power Supply/Deflection Amp PCB (801568) to the CRT.		Press 1mV(PUSH) cal switch. If there is a signal to CRT see 15.
	a. Faulty No-fade PCB.	Test No-fade PCB.
	b. Faulty Deflection Amp PCB.	Test Deflection Amp PCB. If OK see 19.
19. No isolated power to ECG Preamplifier (800101) (801873).	a. Faulty Control PFC connection(s) (801548).	Check at J4-1,2 on Preamp PCB. Check at P1,-19,20 on Low Volt Power Supply (801568). Check Main PFC Assy (801521) pins 19-20 on J2, Power Supply, J4 No-Fade J3, Systole Processor, & P2, on Preamp; Test Low Volt P.S.
20. ECG signal does not freeze.	a. Defective FREEZE switch.	a. Replace FREEZE SWITCH.
	b. Defective no-fade circuit.	c. Check U12c on No-Fade PCB.
21. No systole sound.	a. Defective QRS VOL pot.	a. Replace QRS VOL pot.
	b. Defective operational amplifier or transistor.	b. Check components in systole sound circuit.
	c. Defective audio transducer.	c. Replace transducer.
	d. ECG SIZE control set too low.	d. Adjust for larger ECG signal.

TABLE 4-2 (Continued)
ECG MONITOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
22. Incorrect ECG display. Information is lost or distorted on monitor display.	a. No-fade circuit.	a. Perform no-fade circuit checks, para. 4-13.
23. Incorrect ECG display in presence of transmitting equipment.	a. Loss of RFI shield effect.	a. Open unit and inspect conductive coating on inside of plastic case. If very large scratches or chips are apparent, contact Physio-Control Service Department.
24. Defective SYNC Function (Defib not synchronized to R-wave).	a. Defective slide contacts on Defib. and ECG Monitor. b. ECG SIZE control set too low. c. Defective Main Defib PCB.	a. Check slide contacts on both units. b. Adjust for larger ECG until systole sound is present. c. Check Main Defib PCB.
25. Inaccurate Rate.	a. ECG SIZE control set too low. b. Defective Systole Processor PCB.	a. Adjust for larger ECG until systole sound is present. b. Perform Rate calibration, para. 4-14.
26. Upper or lower heart rate limits not operating at set rates.	a. ECG size control set too low. b. Defective Systole Processor PCB.	a. Adjust for larger ECG until systole sound is present. b. Perform Rate calibration, para. 4-14.
27. No Rate alarm or systole sound.	a. Defective QRS VOL control. b. Defective audio transducer. c. Defective systole Processor PCB.	a. Replace QRS VOL control. b. Replace transducer. c. Perform rate calibration para. 4-14.

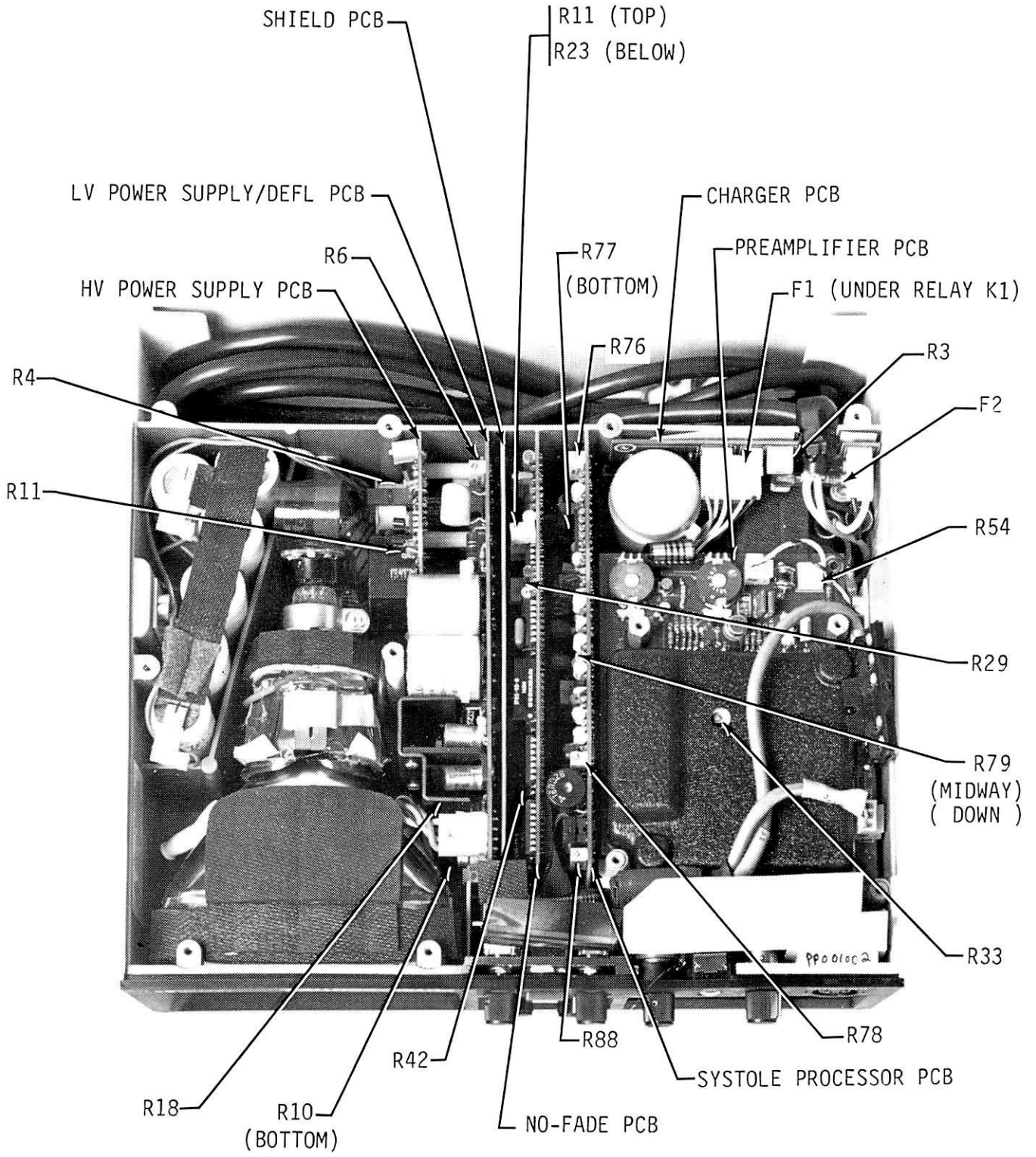


FIGURE 4-1. ECG MONITOR COMPONENT IDENTIFICATION

4-9. Test and Calibration. Procedures provided here are used to verify that the ECG Monitor is operating within specifications. If the instrument is not functioning properly locate the malfunction before attempting final unit calibration or adjustment.

4-10. Initial Control and Setup.

A. Disconnect the AC power cord from the external AC power source.

B. Separate the Cover Assy and Case Assy in accordance with paragraphs 4-24 and 4-25.

C. Set controls to positions as follows:

Nomenclature	Position
POWER	OFF
RECORDER	OFF
QRS VOL	CCW
ECG SIZE	CCW
ECG LEAD SELECT	STD
ALARM LIMITS	OFF

4-11. Power Supply Assembly (800112) Tests. After initial setup of paragraph 4-10, proceed as follows to accomplish power supply testing. Refer to Section 6 for schematics of the Low Voltage Power Supply/Deflection Amp PCB (801568) and the High Voltage PCB (800854).

A. Locate and remove fuse F1 on the Monitor Charger PCB (800157).

B. Set the DC Ammeter to read 500mA full scale. Connect the DC Ammeter in series between the fuse F1 holder terminals.

C. Install the Power Supply Assembly on Extender Board (800336).

D. Connect the Oscilloscope (1MΩ probe) to the drain of Q1 (801568).

E. Depress POWER switch on and verify that the converter amplitude on the Oscilloscope is 34V p-p ±2.5V p-p and the frequency is 19KHz to 24KHz.

F. Verify that the DC Ammeter indicates 490mA ± 50mA.

G. Connect the AC power cord to an AC power source.

H. Connect the Digital Multimeter in turn to the test points indicated in Table 4-3 and verify that the individual power supplies are within tolerance.

TABLE 4-3
POWER SUPPLY VOLTAGE CHECKS

LOCATION 801568		Nominal Voltage	Limits
Test Point	Common	(VDC)	(VDC)
WP1	WP8(P1-13)	+19.0 Unreg.	+16 to +22
WP4	WP8(P1-13)	-19.0 Unreg.	-16 to -22
P1-10	WP8(P1-13)	+12.0 Reg.	+11.5 to +12.5
P1-11	WP8(P1-13)	-12.0 Reg.	-11.5 to -12.5
P1-23	WP8(P1-13)	+ 5.0 Reg.	+ 4.75 to +5.25
J3-1	WP8(P1-13)	+12.0 Reg.	+11.5 to +12.5

I. Depress POWER switch off. Disconnect the AC power cord from the external power source. Remove DC Ammeter and replace fuse F1.

J. Remove the Power Supply Assembly from Extender Board and re-install.

4-12. Preamplifier PCB (800101) (801873) Tests. After completing initial setup of paragraph 4-10, proceed as follows to accomplish Preamplifier testing. Refer to Section 6 for the PBC schematics relative to the following procedure.

A. Common Mode Rejection.

1. Make sure the patient cable is connected to the Monitor.

2. Set the Function Generator to obtain a 5V p-p amplitude at line frequency (50 or 60Hz).

3. Connect one side of the Function Generator to J1-6 (Iso ground) on Preamplifier PCB.

4. Short the Wht, Blk, Red, and Brown leads of the patient cable together and connect to the other side of the Function Generator.

5. Adjust the ECG LEAD SELECT switch to II and depress POWER switch on.

6. Verify that there is less than 500mV p-p output signal on the 1V/mV output jack at rear of instrument.

7. Adjust R33 on 800101 for a minimum signal on the 1V/mV output. Adjust R28 on 801873.

8. Set the ECG LEAD SELECT switch to other lead positions and verify that the signal is less than 500mV on the 1V/mV output jack.

B. Gain.

1. Set the Function Generator for 1mV p-p amplitude at 10Hz.

2. Connect the Function Generator to the Patient Cable between the Wht and Red leads.

3. Set the ECG LEAD SELECT switch to position II. Verify that there is 1V p-p output on the 1V/mV output jack. Adjust R76 on the Systole Processor PCB as necessary.

4. Depress POWER switch off.

C. Notch Filter.

1. Set the Function Generator for a 1mV p-p 60Hz differential signal.

2. Connect the Function Generator to the paddles input on the Preamplifier PCB (J2-1 and J2-3).

3. Set the ECG LEAD SELECT switch to PADDLES.

4. Connect an Oscilloscope to the 1V/mV output and adjust R54 on 800101 (R10 on 801873) for a 60Hz null not to exceed 10mV p-p.

4-13. No-Fade PCB (800159) and Low Voltage Power Supply/Deflection Amp (801568) Adjustments. After completing the initial setup of paragraph 4-10, proceed as follows to accomplish the adjustments. Refer to Section 6 for the PCB schematics relative to the following procedure.

CAUTION

CRT face may be damaged permanently if trace is too bright.

A. Clock Frequency Adjust.

1. Place the No-Fade (800159) PCB on Extender Board 800336.

2. Short the Red and White leads of Patient Cable together.

3. Verify that the ECG LEAD SELECT switch is on the II position and the ECG SIZE control is fully counter-clockwise, but not in X1 position.

4. Connect the Oscilloscope (1MΩ or greater probe) to U19, Pin 4.

5. Depress POWER switch on. Verify clock frequency is 385 ± 10KHz. If not, adjust R42 on the No-Fade PCB. Adjust R42 so that horizontal linearity on CRT is within spec.

6. Remove the Oscilloscope connections.

B. Baseline Offset.

1. Adjust R29, Intensification Adjust, to the fully clockwise position.

2. Set the DVM to read 200mV dc full scale. Connect the DVM between J1, Pin 3 (Vertical Yoke) and ground on the Low Voltage Power Supply PCB.

3. Adjust R23 (on 800159), Baseline Offset, for a 0V ± 10mV output.

4. If necessary, loosen and adjust the yoke for a level (±2mm) horizontal trace and tighten. Adjust the alignment rings on the yoke to vertically center the CRT trace. Adjust R11 on 800159 for proper horizontal positioning.

C. CRT Deflection and Brightness Adjustment.

1. Connect the Function Generator to Patient Cable White and Red leads.

2. Adjust the Function Generator to obtain a 1Hz square wave with an amplitude of 1mV.

3. Adjust the ECG LEAD SELECT switch to II.

4. While observing the Monitor CRT, adjust R16, Horizontal Gain Control, on the Low Voltage Power Supply/Deflection Amp PCB, so that with 4 cycles displayed in the FREEZE mode, there is 25mm ±1mm between peaks. See A5 above for linearity adjust.

5. Set the Function Generator to obtain a 5Hz sine wave with an amplitude of 1mV.

6. Adjust the ECG SIZE control on instrument panel for a 1/2 inch p-p deflection on the CRT. Adjust R6, Intensity Control on the Low Voltage Power Supply/Deflection Amplifier PCB, for adequate brightness on the CRT in a brightly lighted room.

D. R-wave Intensity Calibration.

1. Connect Heart Simulator to the Patient Cable. Adjust the ECG LEAD SELECT switch to II.

2. Adjust the ECG SIZE control for 25mm deflection on the CRT.

3. Adjust the R29, Intensification Adjust, on 800159, so that the R-wave and baseline are near equal intensity.

4. Depress POWER switch off.

5. Remove the No-Fade PCB from the Extender Board and plug the PCB back into the instrument.

4-14. Rate Calibration. After completing the initial setup of paragraph 4-10, proceed as follows to accomplish the Rate meter and Systole sound calibrations. Refer to Section 6 for the PCB schematics relative to the following procedure.

A. Rate Meter.

1. Connect the Function Generator and the Sweep Generator (see Table 4-1) as shown below.

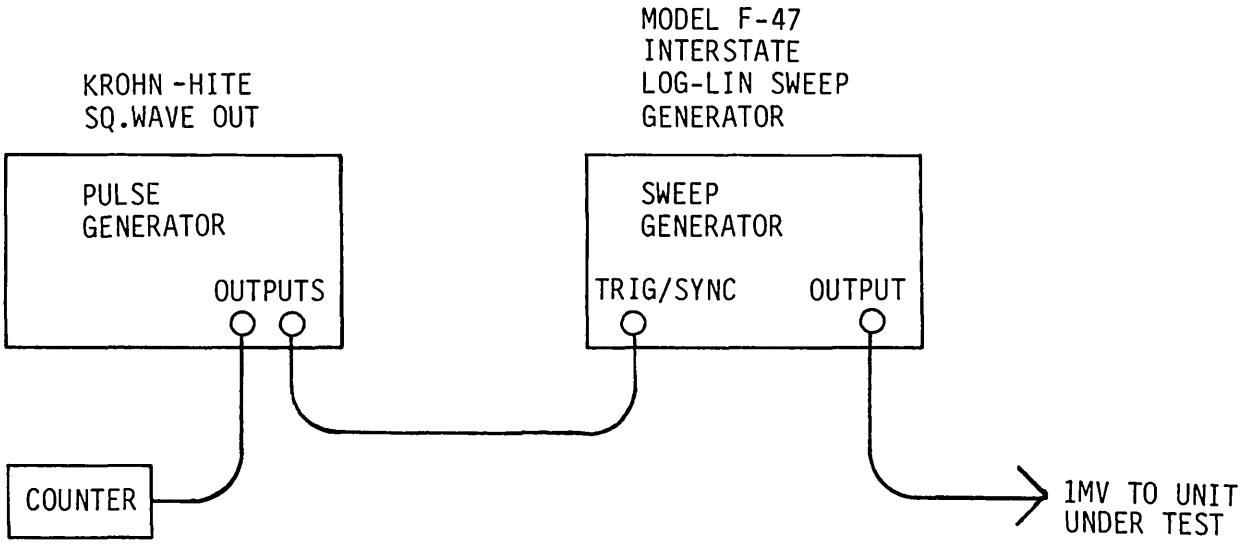


FIGURE 4-2. RATE CALIBRATION TEST SETUP

2. Set the Sweep Generator in the trigger mode with a sine wave output frequency 17Hz. Connect the output to the Patient Cable White and Red leads. Set ECG SELECT switch to II.

3. Adjust the Function Generator to produce a 40mS square wave pulse with a 1mV amplitude.

4. Depress POWER switch on.

5. Set the Function Generator to give 30 BPM on the Frequency Counter.

6. Adjust R88 on the Systole Processor PCB (801445) to display a reading of 30 BPM on the CRT of the Monitor Unit under test.

NOTE: ECG SIZE control may have to be increased slightly.

7. Set the Function Generator to give 240 BPM on the Counter. Adjust R78 on the Systole Processor PCB (801445) to display a reading of 240 BPM on the Monitor Unit CRT.

8. Set the Function Generator to give 60 BPM on the Counter. Adjust R88 on the Systole Processor PCB until 60 BPM is just displayed.

9. Set the Function Generator to give 120 BPM on the Counter. Adjust R78 on the Systole Processor to display 120 BPM on the Monitor.

B. Rate Alarms.

1. Set the period of the square wave to 0.25 seconds (240 BPM). Set the HIGH ALARM LIMIT switch at 240 BPM. Adjust R79 on Systole Processor PCB to the point where a solid alarm tone is first heard.

2. Set LOW ALARM LIMIT switch to 60 BPM. Adjust the Function Generator frequency down until the low alarm limit tone is heard. Verify the period of the input square wave is 1 ± 0.1 seconds.

3. Verify that the alarm sound has approximately the same volume as the systole sound at maximum gain setting and is unaffected by the QRS VOL control. (Checks interconnect flex harness wiring).

C. Systole Sound.

1. Set Function Generator for a square wave period of 1.0 second (60 BPM).

2. With the QRS VOL control set at minimum, the systole sound signal should be inaudible.

3. Turn the QRS VOL clockwise until audible. The systole sound should be audible at the rate of one pulse per second and should correspond to the pulses observed on the Cardioscope.

4. Depress POWER switch off. Remove the Function Generator from the patient cable.

4-15. Frequency Response Test. After completing initial setup described in paragraph 4-10, proceed as follows:

A. Recorder DIAG.

1. Adjust the Function Generator to produce a 10Hz, 1mV sine wave.

2. Connect the Function Generator to Patient Cable White and Red leads. Adjust the ECG LEAD SELECT switch to position II.

3. Depress POWER switch on. Adjust the RECORDER switch to the DIAG position.

4. Adjust the ECG SIZE control for a 5mm p-p display on the Recorder.

5. Verify the frequency response of the Recorder with the Function Generator adjusted to 0.05Hz, 1, 10, 20, 40, 60, 80 and 100Hz. Recorder amplitude should remain constant at 5mm through 50Hz and roll off to 3.5mm p-p minimum at 0.05Hz and 100Hz.

6. Turn the RECORDER switch to the OFF position.

B. 1V/mV ECG Output.

1. Repeat item A above while observing the ECG OUT jack using the Oscilloscope probe.

C. Recorder Delay Time.

1. Adjust the RECORDER switch to the DELAY position.

2. Adjust the Function Generator to produce a 10Hz, 1mV sine wave. Adjust the ECG SIZE control for a 10mm p-p display on the Recorder.

3. Verify the frequency response of the Recorder with the Function Generator set to 1, 10, 20, and 40 Hz. Recorder should roll off at approximately 0.5Hz and 40Hz.

4. Adjust the RECORDER switch to the OFF position.

D. CRT Frequency Response.

1. Repeat item C above while observing the Monitor CRT.

2. CRT response should at least be 7mm p-p at 30Hz.

3. Depress POWER switch off.

4-16. Size Control Test. After completing initial setup of paragraph 4-10, proceed as follows:

A. ECG Gain Test.

1. Adjust the Function Generator to produce a 10Hz sine wave with an amplitude of 1mV.

2. Adjust the ECG LEAD SELECT switch to position II.

3. Connect the Function Generator to Patient Cable White and Red leads.

4. Depress POWER switch on.

5. With the Oscilloscope probe connected to the ECG OUT jack, verify that the 1V output is 1V p-p and the 1mV output is 1mV p-p. Adjust R76 on the Systole Processor PCB as needed.

6. Turn the ECG SIZE control to X1.

   Turn the RECORDER to DIAG.

   Adjust R77 on the Systole Processor so that Recorder trace is 1 ± .05cm p-p.

NOTE: The accuracy of this measurement depends on the accuracy of the 1mV p-p input.

B. CRT Size Test.

1. With the instrument operating as in item A above, adjust the ECG SIZE control to minimum. Verify that the CRT signal displayed is 1mm to 3mm.

2. Adjust the ECG SIZE control to maximum and verify that the signal displayed is 4cm to 6cm p-p.

C. Recorder Size Test.

1. With the instrument operating as in item A above, adjust the ECG SIZE control to produce a 3cm p-p signal on the CRT.

2. Adjust the RECORDER switch to DIAG. Verify that the signal produced is 1.7cm ±0.2cm p-p.

3. Adjust the RECORDER switch to DELAY. Verify that the signal produced is 1.7cm ±0.2cm p-p.

4. Adjust the RECORDER switch to OFF.

5. Depress POWER switch off.

4-17. Monitor Charger PCB (800157) Tests. After completing the initial setup of paragraph 4-10, proceed as follows. Refer to Section 3 or 6 for the PCB schematics relative to the following procedure.

A. Battery Charge Current and AC Rectified Voltage Check.

1. Connect a DC Ammeter (500mA range) in series with the positive battery lead and battery terminal.

2. Connect the AC power cord to the AC power source. Depress POWER switch on.

3. Verify that the battery charge current is approximately 135mA ± 30mA dc and the BATT CHG indicator is illuminated.

4. With the DMM, measure the positive voltage at POWER switch with respect to ground (negative terminal of battery). Verify that the voltage is +19 ± 2.0Vdc.

5. Depress POWER switch off. Disconnect the AC power cord from the AC power source.

6. Disconnect the DC Ammeter.

B. Battery Level Meter Calibration.

1. Disconnect the battery leads from the battery.

2. Connect the DC Power Supply (see Table 4-1) between the positive battery lead and the negative battery lead.

NOTE: Be careful to observe proper polarity.

3. Adjust the DC Power Supply to provide 13.2Vdc. Depress POWER switch on.

4. Adjust R3, on the Battery Charger PCB, for an indication of mid-scale (Red-Green interface) reading on the BATT LEVEL meter on instrument front panel.

5. Depress POWER switch off. Disconnect the AC power cord from the AC power source and the DC Power Supply.

6. Reconnect the battery leads to the battery.

4-18. Millivolt (1mV) Calibration Test.

A. Connect the Oscilloscope probe to the 1V ECG OUT jack. (Tip 1V, Ring 1mV, Sleeve G.)

B. Depress POWER switch on. Adjust the ECG LEAD SELECT switch to STD position.

C. Depress the 1mV CAL button and verify that the 1V ECG OUT is 1V ±0.1V p-p.

D. Depress POWER switch off.

4-19. Lead Select Tests.

A. Lead Select Verification.

1. Adjust the Function Generator to produce a 4ms square wave pulse with 1mV amplitude.

2. Depress POWER switch on.

3. Verify the appearance of signals on the CRT, in all ECG LEAD SELECT switch positions given in Table 4-4.

TABLE 4-4

LEAD SELECT VERIFICATION TEST

ECG LEAD SELECT Switch Position	Function Generator Connections to Patient Cable
I	White - Black
II	White - Red
III	Black - Red
AVR	Black & Red - White
AVL	White & Red - Black
AVF	White & Black - Red
V	Red, White & Black - Brown

B. R-wave Detector Verification.

1. Connect the Function Generator, as adjusted in item A, to Patient Cable White and Red leads.

2. Adjust the ECG LEAD SELECT switch to position II.

3. Adjust the ECG SIZE control to produce a 2cm signal on the CRT. Verify that the systole indicator flashes on the rate display.

4. Depress POWER switch off. Disconnect the Function Generator from the Patient Cable.

4-20. Offset Check.

A. Adjust the Function Generator to produce a 1mV p-p, 10Hz signal. Connect the Function Generator to a DC Power Supply and Patient Cable as shown in Figure 4-3.

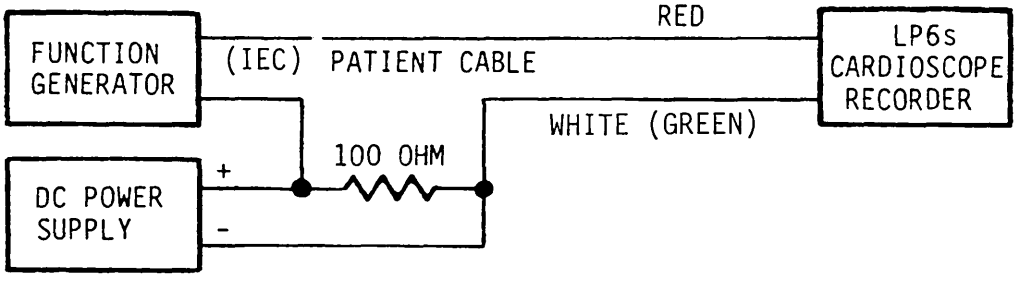


FIGURE 4-3. OFFSET CHECK SETUP

B. Adjust the DC Power Supply to produce +1Vdc and turn off.

C. Depress POWER switch on. Adjust the ECG SIZE control for a 3cm p-p trace on the CRT. Switch the DC Power Supply on and observe trace on CRT. Verify that the trace returns to the CRT center line within 3 seconds.

D. Turn DC Power Supply off and reverse the connection at the power supply terminals to produce a -1Vdc signal. Repeat Step 3 above. Depress POWER switch off.

4-21. Leakage Test.

A. Verify that the POWER switch is off and the AC Mains (Power) Cord is disconnected from the AC power source.

B. Using a Multimeter, measure the resistance between the ground wire of the AC Mains (Power) Cord and the patient connector shell. Verify that the resistance is greater than 20MΩ.

4-22. Recorder Assembly (801862) Adjustments. Remove the Recorder Assembly from the ECG Monitor unit in accordance with paragraphs 4-31 A and B.

A. After completing the removal of Recorder assembly, place it on a level surface. With power off and no input signal, insure that the stylus is mechanically centered to within ±1.5mm.

B. Set the DC Power Supply to obtain + and - 12Vdc.

C. With the DC Power Supply off, connect minus (-) lead to pin 4 and the positive (+) lead to pin 5 of J1. Connect the ground lead to pins 1 and 2 of J1.

D. Set the Function Generator to obtain a 1Hz ±0.1 percent square wave input. Connect one side of the Function Generator to pin 3 of J1.

E. Connect the other side of the Function Generator to J1-6.

F. Connect the Oscilloscope to measure the differential voltage between Q1 collector and Q2 collector.

G. Upon simultaneous turn-on of the plus 12 volt supply at J1-5 and the minus 12 volt supply at J1-4, a peak voltage of 22 ± 2 volts should be initially observed between Q1 and Q2.

H. Within 2 ± 1 seconds, the peak voltage between Q1 and Q2 shall fall to 11 ± 1 volts.

I. Voltage Measurements.

1. The voltage at U3-9 should be +7.56 ± 0.3 volts.

2. The voltage at CR2-Cathode should be +5.1 ± 0.3 volts.

3. The voltage at J2-5 should be +5.1 ± 0.3 volts.

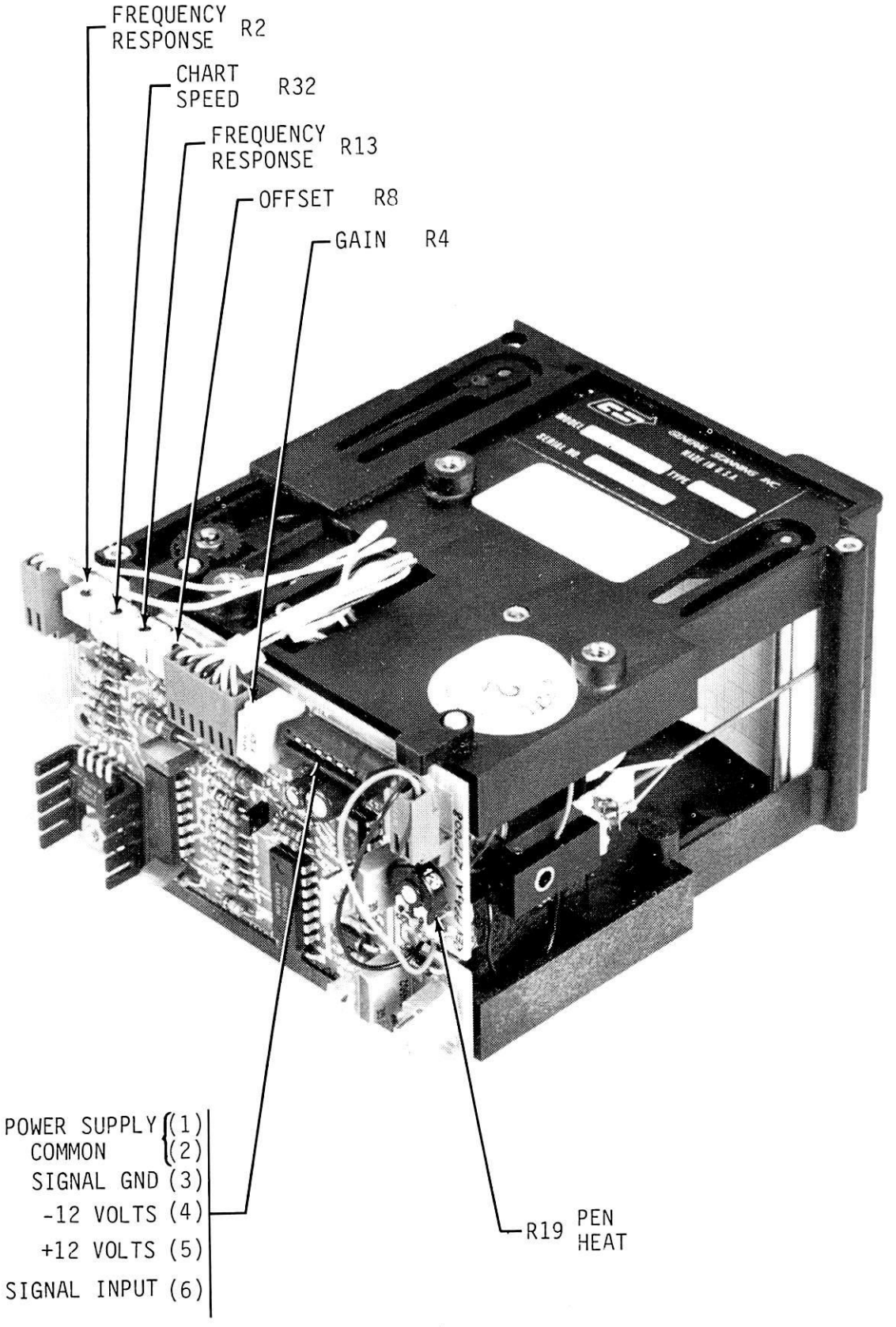


FIGURE 4-4. RECORDER ASSEMBLY

4. The voltage at CR1-anode should be -5.1 ± 0.3 volts.

5. The voltage at U4-7 should be -5.1 ± 0.4 volts.

J. Adjustments.

1. Stylus Heat.

Connect the Oscilloscope to Q1 - collector (TAB). Set the Function Generator for a 5Hz, 20mm sine wave. Adjust stylus heat control R19 to the minimum setting required to obtain a uniform line. Adjust R19 in small increments, allowing 5 seconds after each adjustment to allow stylus temperature to stabilize. Verify the signal is a square wave, 11± 1 volt peak.

2. Paper Motor Speed.

Set the Function Generator for a 1Hz, 5mm square wave.

Adjust paper speed control R32 for a 25mm distance between leading edges of the square wave. The distance between the leading edges of six square waves should be 150 ± 3mm.

3. Pen Motor Frequency Response, Centering and Gain.

Turn R4 full CCW and R13 full CW, and R2 full CCW (MIN.).

Set the Function Generator to minimum amplitude. Adjust R8 for a centered trace.

Turn R4 to approximately mid-position.

Set the Function Generator to sweep between 0.5Hz and 100Hz with a 1V p-p sine wave. Adjust R13 to minimize droop in recorder frequency response.

Set the Function Generator to 100Hz sine wave, 1V p-p. Adjust R2 for maximum recorder amplitude.

Reset the Function Generator to its original sweep setting and adjust R13 for flat midband response.

Repeat the two adjustments above for R2 and R13.

Verify that the frequency response is flat ± 2mm between 0.5Hz and 100Hz.

Set the Function Generator to 10Hz 1V p-p. Adjust R4 to give 1 ± .05cm p-p deflection.

4-23. Alarm Activated Recorder Logic PCB Tests (801546).

Remove the AAR PCB (801546) as described in paragraph 4-39.

Using the PFC extender cable (802083) and PFC removal tool (800742), connect the AAR PCB to P1 via J1 and place the extended PCB clear of the monitor unit.

A. Turn on POWER.

B. Check +12V with a digital voltmeter at J1-6.

C. Check -12V at J1-5. Check U1-16 for +5V. (Recorder may be turned on by setting a LOW LIMIT alarm (20BPM), with the RECORDER switch on AUTO).

D. Check -AAR output at J1-2; read OV when the recorder is not running, read -12V when recorder is running.

E. Check +AAR output at J1-3; read OV when the recorder is not running, +12V when it is running.

F. With POWER off, connect test Oscilloscope to U1-6.

G. With POWER on, and an alarm condition, U1-6 should be low for about 1/2sec before switching to +12V.

H. Set a LOW LIMIT alarm (20BPM) with ECG LEAD SELECT set to STD.

I. Check that a baseline appears on the monitor CRT, and that the alarm sounds.

J. Connect the test Oscilloscope to J1-4, check that it is Low (-12V)

K. Check that U2-7 goes low, (-12V).

L. Check that U1-5 is also low, (OV).

M. Reset the LOW LIMIT alarm to stop the alarm signal.

N. Connect the test Oscilloscope to U1-6.

O. Operate the LOW LIMIT alarm to 20BPM, and check that U1-6 is high for about 1 sec, then goes low.

P. Repeatedly reset and operate the LOW LIMIT alarm while making the following checks with the test Oscilloscope:

   1. Check that U1-13 is high.

   2. Check that pins U1-10, U1-12 are high for about 18 seconds and then go low.

   3. Check that pin U1-9 is low for about 18 seconds, then goes high.

   4. Check that while U1-6 is high, the output on the comparator, U2-1 is high (+5V)

   5. If the voltage at U1-9, & U1-10 are ok, check Q1,Q2,Q3,Q4, and CR3.

4-24. Major Component Removal and Installation. Paragraphs 4-24 through 4-39 provide the sequence for removing and installing the major components of the ECG Monitor.

CAUTION

Disassembly should always be accomplished with the AC power cord disconnected from the AC power source.

Installation is for the most part the opposite of removal therefore only the removal procedures are provided. Special installation notes as required are provided as part of the removal or disassembly procedure. Disassemble only to the extent required. Figure 4-5 provides an exploded view of the ECG Monitor to assist in the following procedure.

CAUTION

Use the PFC Removal Tool (See Table 4-1) when removing the Printed Flex Circuit Assy (PFC) from connectors. Non-repairable damage to the PFC may occur if this tool is not used.

4-25. Access Cover Removal. Refer to Figure 4-5 and proceed as follows:

A. Position module so that upper part of case is down.

B. Remove eleven screws **1** securing cover **2** to case **3** .

C. Lift cover **2** and rotate it to the right upside down.

D. Remove retaining screw **33** from Interconnect Assy **32** and separate Interconnect from cover.

E. At this point the Monitor is in the test configuration. If further disassembly is required, proceed to the applicable paragraph.

4-26. No-fade PCB Removal. After completing procedures in paragraph 4-25, the removal of the No-Fade PCB **4** is accomplished by lifting the PCB up and out of the card guides.

4-27. Systole Processor PCB Removal. After completing procedures in paragraph 4-25 proceed as follows:

A. Lift the Systole Processor PCB **5** up slightly and disconnect the flex cable connector **6** from the PCB.

B. Lift Systole Processor PCB **5** up and out of the card guides.

4-28. Power Supply Assembly Removal. After completing procedures in paragraph 4-25, proceed as follows:

A. Disconnect the yoke connector 34 from the Low Voltage Power Supply/Deflection Amp PCB of the Power Supply Assembly 7 . Disconnect the anode connector 23 at the CRT 8 .

B. Lift the Power Supply Assembly 7 up and out of card guides.

NOTE: It may be necessary to raise the CRT 8 up slightly to allow the anode lead wire to clear the CRT assembly.

4-29. Monitor Charger PCB Removal. After completing the procedures of paragraph 4-25 proceed as follows:

A. Disconnect the power cord assembly connector 13 and transformer assembly connector 11 from the Monitor Charger PCB 9 .

B. Remove the Monitor Charger PCB 9 by lifting it up and out of the card guides.

4-30. Preamp PCB Assy Removal. After completing the procedures in paragraph 4-25 proceed as follows:

A. Remove two rear standoffs 14 and pull the PCB up from the forward plastic retaining clip 37 .
B. Lift the Preamp PCB 15 up slightly and remove the two flex circuit connectors at J1 and J4 on the PCB.

C. Remove the two Interconnect Assy 32 connectors from J2 and J3 on the PCB.

D. Remove the Preamp PCB 15 by lifting it up and out of the instrument.
B. Lift the Preamp PCB 15 up slightly and remove the two flex circuit connectors at J1 and J4 on the PCB.

C. Remove the two Interconnect Assy 32 connectors from J2 and J3 on the PCB.

D. Remove the Preamp PCB 15 by lifting it up and out of the instrument.

4-31. Recorder and Recorder PCB Assembly Removal. After completing the procedures in paragraphs 4-25 and 4-30 proceed as follows:

A. Remove four standoffs 18 and three mounting screws 19 .

B. Remove the ground wire 38 if present and recorder mounting plate 20 .

C. Loosen two Recorder PCB retainers 48 . Raise Recorder PCB 22 enough to remove flex circuit from the connector 39 and to remove connectors 46 and 47 from the Recorder PCB.

D. Remove Recorder PCB 22 .

E. Lift the rear of the Recorder Assembly 21 up first and then slide assembly up at an angle and out of the instrument case.

4-32. CRT Removal. After completing the procedures of paragraph 4-25 proceed as follows:

A. Disconnect the main PFC connector 40 from rear of CRT 8 .

B. Remove the anode lead 23 from the CRT.

C. Lift the rear of the CRT up slightly and move the CRT back, clearing the case mounting bosses, then remove the CRT 8 by lifting it up and out of the instrument.

4-33. Power Cord Assembly Removal. After completing the procedures of paragraph 4-25 proceed as follows:

A. Disconnect the power cord assembly connector 13 from the Charger PCB 9 .

B. Disconnect the ground lug 41 from attachment plate 24 .

C. Lift power cord assembly 10 up and out of the instrument. (Strain relief assembly comes off with power cord assembly).

D. For units with Appliance Connector assemblies, remove two mounting screws and lift out Appliance Connector Assembly 10B .

4-34. Transformer Assembly Removal. After completing the procedures of paragraph 4-25, 4-28, and 4-29 proceed as follows:

A. Remove connector 11 from the Charger PCB 9 .

B. Lift transformer assembly 12 up and out of instrument case.

4-35. Battery Removal. After completing the procedures of paragraph 4-25, the removal of the Battery Pak 25 is accomplished by disconnecting the slide-on wire lugs connected to the terminals and lifting the assembly up and out.

4-36. Monitor Control PFC Assembly Removal. The procedures of paragraphs 4-25, 4-26, 4-27, and 4-31, steps 1 through 3, must be accomplished before the following procedure can be performed.

CAUTION

Use the PFC Removal Tool (see Table 4-1) when removing a PFC from connectors. Non-repairable damage to a PFC may occur if this tool is not used. When installing the PFC's, it is important to maintain the original routing.

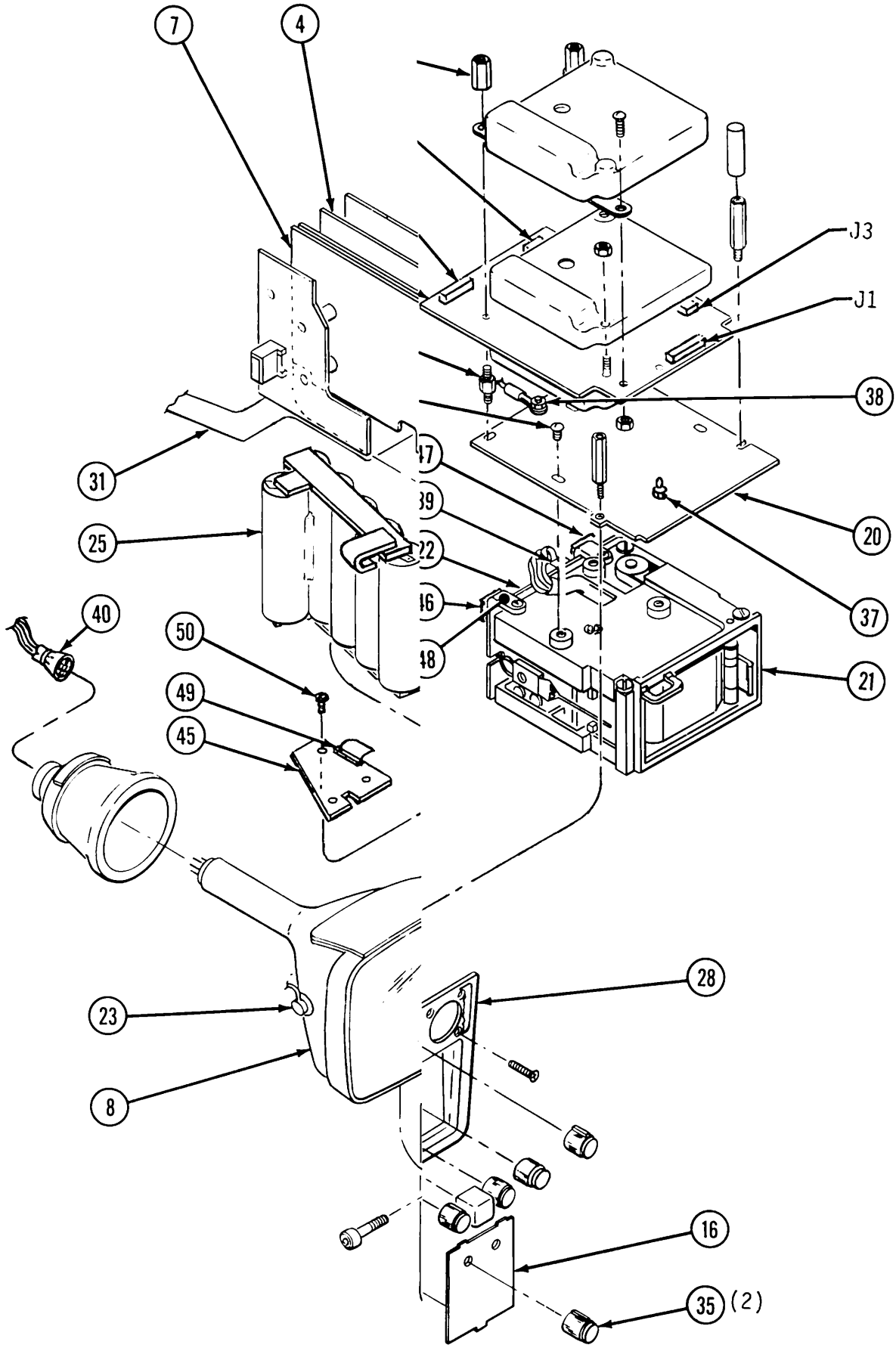


FIGURE 4-5. ECG MONITOR MAJOR COMPONENT REMOVAL

A. Remove right angle fastener 43 from the BATT level indicator.

B. Remove the control and logo labels.

C. Remove the control knobs from the following controls; ECG LEAD SELECT, QRS VOL/1mV (PUSH), ECG SIZE/FREEZE (PUSH), and POWER.

D. Remove nut from RECORDER switch. Remove switch from bezel mounting being careful not to dislodge washer and lockwasher on switch. Replace nut on switch to retain washer and lockwasher in proper order and to facilitate reassembly.

E. Remove eight screws 27 around bezel 28 .

CAUTION

DO NOT FORCE BEZEL OUT OF THE CASE. The plastic protrusions at the bottom of the bezel could be damaged.

F. Tilt the upper end of the bezel, with respect to the instrument being upside down, out slightly forward and lift the bezel assembly out of the instrument case at an angle.

G. Remove the mounting hardware from the following controls; ECG LEAD SELECT, QRS VOL/1mV (PUSH), ECG SIZE/FREEZE (PUSH), and POWER.

H. Disconnect the flex connector from the Main PFC Assembly 31 near the Systole Processor PCB 5 location.

I. Remove the Control PFC Assembly 30 from the double backed tape located on the inner case recorder wall and lift it from the instrument.

4-37. Display PCB Assembly Removal. After completing the procedures in paragraphs 4-25, 4-26, 4-27, 4-31 and 4-36 proceed as follows:

A. Remove the two rate limit alarm adjustment knobs 35 and disconnect flex cable connector 26 from the PCB.

B. Remove front panel 16 and one mounting screw 36 behind panel from instrument.

C. Move the Display PCB 17 back and then lift the PCB up and out of the instrument.

4-38. Main PFC Assembly Removal. The procedures of paragraps 4-25, 4-26, 4-27, and 4-28, respectively, must be performed before the following procedures can be accomplished.

A. Remove the 1V/mV output connector 29 mounting nut and washer.

B. Disconnect the Main PFC connector 40 from rear of CRT 8 .

C. Remove two slide-on wire lugs connected to the battery terminals.

D. Remove eight mounting screws which secure the PCB edge connectors to case.

E. Remove the ground screw **44** and wire attached.

F. Remove PFC connector **49** from the Alarm Activated Recorder PCB **45** .

G. Lift out the Main PFC Assembly **31** and insulator which are folded together.

4-39. Alarm Activated Recorder PCB Removal. The procedures of paragraphs 4-25, 4-27 and 4-31 must be accomplished before proceeding as follows:

A. Remove PFC connector **49** from the Alarm Activated Recorder PCB **45** .

B. Remove three screws **50** from PCB **45** .

C. Remove Alarm Activated Recorder PCB **45** from the instrument.

4-40. DC DEFIBRILLATOR UNIT

Paragraphs 4-41 through 4-66 provide maintenance procedures for the DC Defibrillator and are divided into three topics: Troubleshooting, Test and Calibration, and Major Component Removal and Installation.

Figure 4-6 provides an overall view of the DC Defibrillator unit with key component locations called out.

WARNING

The LIFEPAK 6s Defibrillator stores and delivers a potentially hazardous amount of energy if discharged accidentally. All test and service personnel must be familiar with this unit before attempting to work on it.

THE FOLLOWING PRECAUTIONS SHOULD BE TAKEN:

A. Before removing components or disconnecting the Main Defibrillator PCB Assembly (801820), disconnect the Defibrillator Unit from the AC power supply. Disconnect the battery connection (P1 of B1) from the Defibrillator Charger PCB (J1 of A2).

B. Discharge the main defibrillator capacitor (C1) using an insulated resistor 5K to 20K ohm, 50W, 5KV. The resistor should be connected during all work on the Defibrillator Unit, until the Unit is ready to operate. The probe or clips used to connect the resistor should be insulated to withstand 20KV.

4-41. Troubleshooting. Troubleshooting should start with observing for obvious symptoms such as odors or discoloration from overheated components. Use Table 4-5, DC Defibrillator Troubleshooting Guide, to aid in the isolation of specific malfunctions. Refer to paragraph 4-56 for Major Component Removal and Installation instructions.

TABLE 4-5
DC DEFIBRILLATOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Unit does not function when POWER 1 switch is depressed.	a. Defective fuses on Main Defibrillator PCB (801820).	a. If 15 amp fuse F1, only. Check for defective CR2, or Q24, Q23 on Main PCB. If 1.25 amp Fuse F2, only. Check for defective U1 or U4 on Main Defibrillator. If 2.5 amp fuse F3 has failed, check CR3, Q12, CR15, Q1, Q2, on Main Defibrillator, transfer relay coil, and dump relay coil.
	b. Battery discharged below minimum operating level.	b. Operate unit on AC BATT power. Check BATT CHG is lit. Check for output from Charger PCB at P1, Pins 1 and 2 with battery disconnected. Check Charger PCB for defective components Q5, Q6, Q7 or CR13.
	c. Defective CHARGE 3 pushbutton on the paddles or front panel.	c. Check for shorted CHARGE pushbuttons Q25 inhibits normal operation of unit if CHARGE switches appear depressed when POWER 1 is turned on.
	d. "Watchdog circuit" is inhibiting operation. U1 "FAIL LED" is on.	d. Check U1, Pin 37 for the normal 1KHz signal. If OK: check the "Watchdog" timer U9 on Main Defibrillator PCB.

TABLE 4-5 (Continued)
DC DEFIBRILLATOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
2. Unit fails to stop Charging at energy level selected.	a. ENERGY SELECT 2 circuitry defective.	a. Check resistor network RN1 on Defibrillator Control circuit. Check for defective U1, CR18, 19, 21, U7, R46, 47, R12, R1, C3 on Main PCB. Check circuit continuity from Control Panel to Main Defibrillator PCB.
3. Unit fails to remain Ready after charge.	a. Defective Dump Relay circuit.	a. Check for defective U1, Q12, CR3, CR24 on Main Defibrillator PCB.
4. Unit fails to transfer energy after charge.	a. Defective transfer circuitry.	a. Check for defective U3, U4, Q2, or CR3 on Main PCB. Check paddle discharge transfer switch. Check Paddle interlock continuity.
	b. Defective Arm Circuit. (READY lights go out when Paddle buttons are depressed.)	b. Check Q2, Q4, Q5, Q9, on Main Defibrillator PCB.
5. Unit does not charge when a CHARGE 3 Push-button is depressed.	a. Battery below operating limit.	a. Recharge battery.
	b. ENERGY SELECT 2 circuitry defective.	b. Check resistance network on Control PFC circuitry.
	c. Open circuit on paddle interlock.	c. Check paddle connector engagement. Check interlock continuity.
	d. CHARGE 3 Push-button circuitry defective.	d. Check CHARGE Push-button continuity on front panel or Paddles.

TABLE 4-5 (Continued)
DC DEFIBRILLATOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
5. (Continued)	e. Transfer Relay defective.	e. Check for continuity on relay charge contacts and wiring.
	f. Charge Command, flyback circuitry defective.	f. Check for defective Q23, Q24, U1, U8, U5, Q21, Q22, Q27, CR10, Q19, Q20, Q12, CR13, CR14 on Main Defibrillator PCB.
6. Ready light on Paddles does not light at any time (or on constantly). Front panel light working correctly.	a. LED defective.	a. Replace LED.
	b. Ready light circuitry defective.	b. Check for defective on Q8, C27 Main Defibrillator PCB.
7. Charge time exceeds 10 seconds to reach 260 (400) joule level.	a. Timing potentiometer out of calibration.	a. Perform charge timing test per para. 4-46 using R61 and R62.
	b. Energy level potentiometer out of calibration.	b. Check R60 calibration per para. 4-47.
	c. Battery below normal level (80% discharged).	c. Recharge battery. Use AC power.
8. Unit automatically charges when turned on.	a. Faulty charge control circuitry.	a. Check for defective U1, C20, U6 and +2.5V, +5V on Main Defibrillator PCB.
9. Excessive noise when monitoring in Paddles Mode. (ECG Quick-Look)	a. Transfer Relay ECG contacts faulty.	a. Replace Transfer Relay.
	b. ECG wiring faulty.	b. Check continuity.
	c. Interconnect faulty.	c. Check Contact resistance.

TABLE 4-5 (Continued)
DC DEFIBRILLATOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
10. Battery level meter not indicating or in error.	a. Meter faulty.	a. Replace meter.
	b. Meter circuitry defective.	b. Check continuity of wiring and for defective R63 or CR17 on Main Defibrillator PCB.
	c. Calibration.	c. Perform battery meter calibration using R63 per para. 4-45.
11. TEST LOAD Display does not read selected 100J or 360/400J, or reads "BARS".	a. Defective Test Load Circuitry.	a. Check for defective Test Load rectifiers, transformer, or interconnect on Test Load PCB.
	b. Defective components or adjustments on its Main Defib PCB.	b. Test U1, U7, or CR22 on Main Defibrillator Recalibrate R57 if necessary.
12. Unit fails to bleed down when ENERGY SELECT 2 switch position is changed (Unit Charged).	a. Dump resistor open.	a. Replace Dump Resistor.
	b. Dump relay circuitry defective.	b. Check for defective CR3, Q12, or U1 on Main Defibrillator PCB.
13. Unit fails to reach the higher energy levels.	a. Faulty Charge circuitry.	a. Check the waveforms at Q24, R1, C3 and U7 circuits on Energy Cal.
	b. Leakage in dump relay.	b. Replace relay.
14. AVAILABLE ENERGY Display does not show selected energy at full charge.	a. Energy storage out of calibration.	a. Adjust R60 on Main Defibrillator PCB.
	b. AVAILABLE ENERGY Display out of calibration.	b. Adjust R24 on Main Defibrillator PCB.
	c. Defective U1.	c. Replace U1 on Energy Meter PCB.

TABLE 4-5 (Continued)
DC DEFIBRILLATOR TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
14. (Continued)	d. If display is blank, defective U3 or U4.	d. Replace U3 or U4 on Main Defibrillator PCB.
	e. Display drivers defective. (Display appears, but is not correct reading.)	e. Check Q15-Q17 (Main Defibrillator PCB), Q1, Q2, U1, U2 (Energy Meter PCB).

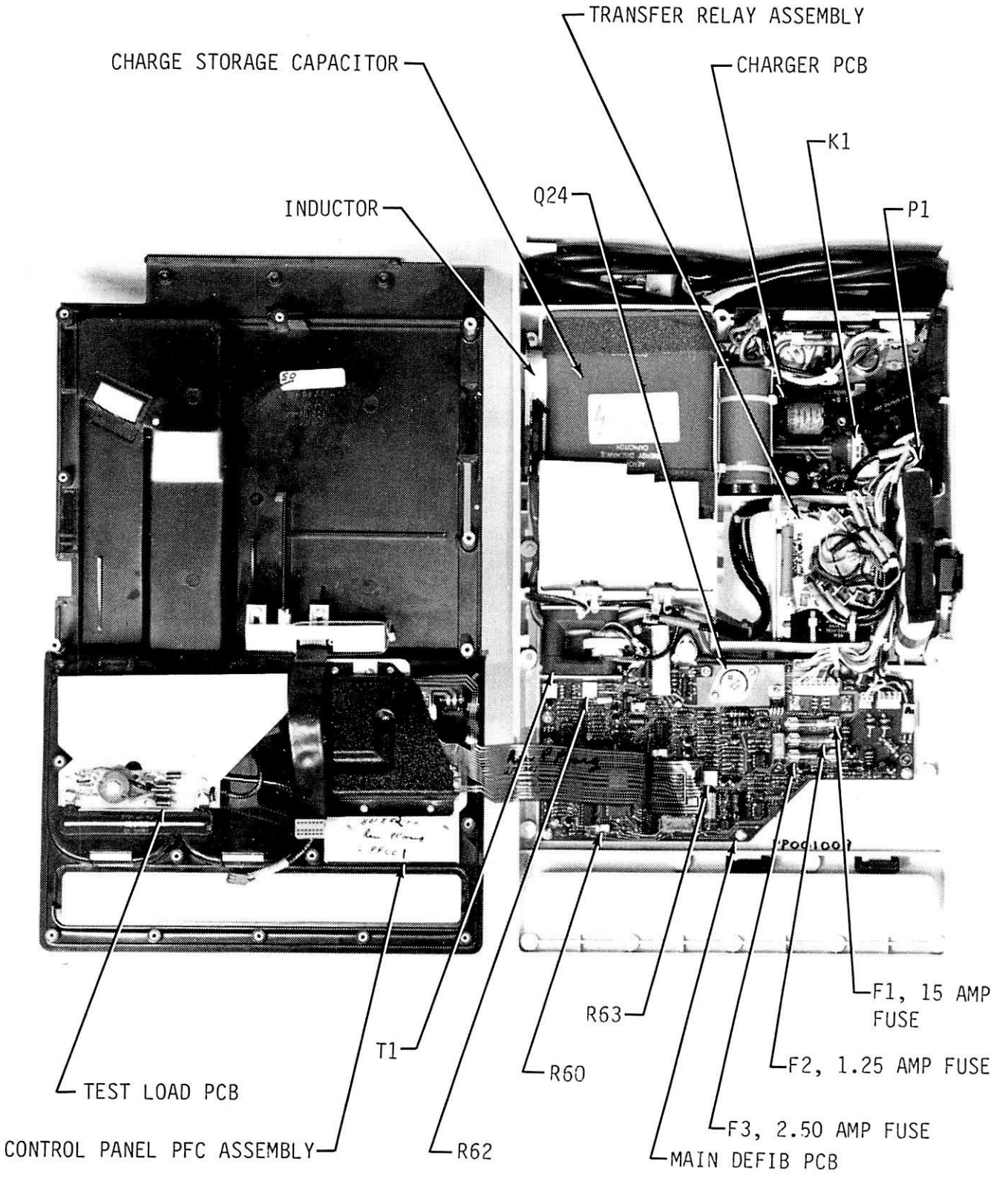


FIGURE 4-6. DC DEFIBRILLATOR UNIT COMPONENT IDENTIFICATION

4-42. Test and Calibration. Procedures provided here are used to verify that the DC Defibrillator is operating within specifications. If the instrument is not functioning properly, locate the malfunction before attempting final unit calibration or adjustment.

4-43. Initial Control and Test Setup.

A. Disconnect the AC Mains (Power) Cord from the external AC power source.

B. Depress POWER 1 switch off and verify that the green indicator lamp is out, indicating that power is off.

C. Separate the Upper and Lower Case in accordance with paragraph 4-57.

D. Fasten external Paddles to Energy Meter (see Table 4-1) electrodes.

WARNING

HAZARDOUS VOLTAGE (5100 volts) IS CONNECTED TO THE PADDLES DURING DISCHARGE OR COULD POSSIBLY BE PRESENT AS THE RESULT OF FAULTY CONDITIONS. It is recommended that the Paddles be fastened to the Energy Test Meter for all charge and discharge tests except for special test requirements.

4-44. Current Drain. After completing initial setup of paragraph 4-43, proceed as follows. Refer to Section 6 for the PCB schematics relative to the procedure.

A. Depress POWER 1 switch off and verify that the green indicator lamp is off.

B. Remove fuse F1 from the Main Defibrillator PCB (801820) and connect a Digital Multimeter (20 ampere range) in series with the F1 fuse holder.

C. Depress POWER 1 switch on and verify that the green indicator lamp is lit.

D. Check that the input current is between 175 ± 35mA dc.

E. Set ENERGY SELECT 2 switch to 360/400 joules. Depress and release the CHARGE 3 pushbutton while observing the Digital Multimeter. The current will continue to increase during the charge cycle until full charge is reached. At full charge it will drop back to minimum current. Verify the current does not exceed 10.0A. Depress POWER 1 switch off.

4-45. Battery Level Meter Test. After completing the initial setup of paragraph 4-43, proceed as follows:

A. Connect the DC Power Supply (Table 4-1) across ground and +J1-6 on the Main Defibrillator PCB. (Be sure to observe for proper polarity).

B. Disconnect the Charger PCB connectors.

C. Adjust the DC Power Supply to 11.8Vdc.

D. Verify that the BATT LEVEL indicator reads in the center of the scale. If necessary, adjust R63 potentiometer on the Main Defibrillator PCB.

E. Disconnect the DC Power Supply and reconnect the Charger PCB connectors.

4-46. Charge Circuit Calibration. After completing the initial setup of paragraph 4-43, proceed as follows:

NOTE: Momentary pressure on the CHARGE **3** pushbutton starts the charge cycle. Once the Defibrillator has charged to the desired level and the CHARGE Indicators stop flashing, the instrument is ready to discharge. If not discharged, the charge will slowly bleed down and when the charge has bled off to approximately 97 percent of the preselected level, the charge refresh circuit operates and recharges to the selected energy level. This sequence repeats itself for about 60 seconds. The display then disappears, and transfer is inhibited.

A. Connect the AC power cord to the external power source.

B. Adjust the ENERGY SELECT **2** switch to 360/400 J.

C. Momentarily Depress the POWER **1** switch on and verify that the green indicator lamp lights.

D. Simultaneously start the stopwatch (see Table 4-1) and press the CHARGE 3 pushbutton. Stop the stopwatch when the CHARGE Indicators stop blinking.

E. Verify that the stopwatch reads less than 10 seconds (nominal 8.0 to 10 seconds, 9.0 to 10.0 seconds on the 240V model). Depress both Paddle Discharge pushbuttons simultaneously and verify energy is displayed on the AVAILABLE ENERGY Display.

F. If necessary, adjust R62 on the Main Defibrillator PCB for charge time of less than 10 seconds.

G. Adjust R61 (Q24 off-time) for maximum frequency of the displayed waveform with minimum ringing. The correctly adjusted waveform seen at T1 Pin 2 is shown in Figure 4-7.

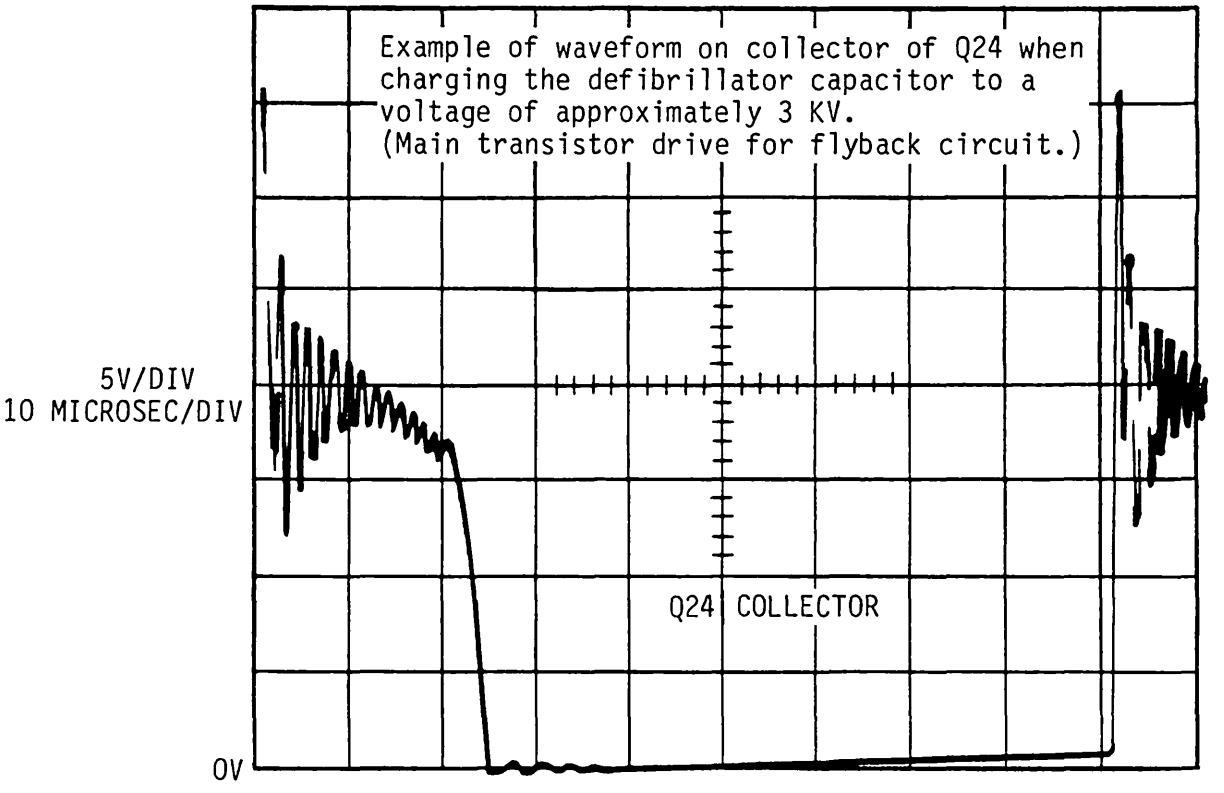


FIGURE 4-7. DC DEFIBRILLATOR KEY VOLTAGE WAVEFORM

H. Repeat steps D, E, and F, if necessary.

I. Readjust R61, if needed.

J. Depress POWER 1 switch off. Check that green indicator light is out.

4-47. Selected Energy Test. (Change Calibration) After completing the initial setup of paragraph 4-43, proceed as follows:

A. Connect P/N 201176-00 jumper block at J10-7 and 3.

B. Connect the AC (Mains) power cord to the external AC power source.

C. Depress POWER 1 switch on. Check green indicator lamp lights.

D. Set ENERGY SELECT 2 switch to 360J or 400J.

E. Depress CHARGE 3 pushbutton, then immediately press both Paddle Discharge pushbuttons and hold them down until instrument discharges into the Energy Test Meter.

F. Verify that the Energy Test Meter indicates between 360 or 400 joules. If necessary, adjust R60, on the Main Defibrillator PCB, for 360 or 400 joules ±12 joules.

G. Repeat this test on the other selectable energy levels and check that the indication on the Energy Test Meter is within the limits given in Table 4-6.

H. Depress POWER 1 switch off. Verify that the green indicator extinguishes.

TABLE 4-6
ENERGY SELECT TOLERANCES

ENERGY - JOULES	LIMIT (JOULES)
5	5 (APPROX.)
10	7 - 13
20	17 - 23
30	27 - 33
50	47 - 53
100	96 - 108
150	141 - 159
200	188 - 212
300	282 - 318
360	338 - 382
400 (optional)	375 - 425

4-48. Energy Meter Calibration. The Charge Calibration given in para. 4-46 must be completed before the Energy Meter Calibration. This test must be performed in the "calibrate mode", and the jumper block should be set accordingly.

Adjust R24 to read 366 or 406 on the display. Select each energy range in the table below, Charge the unit and check that the AVAILABLE ENERGY display is within the limits given.

ENERGY RANGE	TOLERANCE
5	5 ± 0
10	8 - 12
20	18 - 22
30	28 - 32
50	46 - 54
100	92 - 108
150	140 - 160
200	188 - 212
300	286 - 314
360	342 - 378
400 (Optional)	380 - 420

4-49. Time-out. After completing the initial setup of paragraph 4-43, proceed as follows:

A. Connect the AC (Mains) power cord to the external AC power source.

B. Depress POWER 1 switch on. Verify green indicator illuminates.

C. Set the ENERGY SELECT 2 switch to 360/400J.

D. Depress the CHARGE 3 pushbutton and allow the instrument to charge. Start the Stopwatch when the CHARGE Indicators come on steady. Stop the Stopwatch when the CHARGE Indicators are blank.

E. Verify that the energy cannot be transferred and time-out occurs between 64 to 70 seconds.

F. Depress the CHARGE 3 pushbutton and verify transfer of energy when the CHARGE Indicators are on steady.

G. Depress POWER 1 switch off. Verify green indicator light extinguishes.

4-50. Output Waveform and Pulse Duration. After completing the initial setup of paragraph 4-43 and the Selected Energy Test of paragraph 4-47, proceed as follows:

A. Connect the Test Oscilloscope (Table 4-1) to the BNC connector on back of the Energy Test Meter (Table 4-1). Connect Oscilloscope camera to the oscilloscope. Set Oscilloscope to 0.5V/div, 1ms/div and positive trigger (single sweep).

B. Depress POWER 1 switch on. Verify that the green indicator lamp lights.

C. Adjust the ENERGY SELECT 2 switch to the maximum energy level (360 or 400J).

D. Depress CHARGE 3 pushbutton and allow instrument to charge.

E. Depress the Paddle Discharge Pushbuttons and record waveform with the Oscilloscope camera.

F. Check that the display closely matches that of Figure 4-7. The curve should be smooth and continuous, and the entire pulse duration should not exceed 10ms (at 10% of peak value), and is less than or equal to 2A.

G. Depress POWER 1 switch off. Verify that the green indicator goes out.

H. Disconnect and remove Oscilloscope.

4-51. Internal Discharge (Dump). After completing the initial setup of paragraph 4-43, proceed as follows:

A. Set the ENERGY SELECT 2 to the maximum level.

B. Depress POWER 1 switch on. Verify that the green indicator illuminates.

C. Depress CHARGE 3 pushbutton and allow instrument to charge.

D. When instrument is in ready state (CHARGE Indicators on steady), change the ENERGY SELECT 2 position. Verify that the dump circuit functions. (CHARGE light goes out, DISPLAY is blank.)

E. Recharge instrument to the maximum energy level, (300 or 400J).

F. Select 5J, start the stopwatch and hold CHARGE button down.

G. Check that the READY light comes on at 5J within 12 seconds. This indicates the full energy charge was properly discharged internally.

H. Depress POWER 1 switch off. Verify green indicator lamp goes out.

4-52. Test Load Check.

A. Place Paddles in Test Load holders on instrument. (Firmly press down.)

B. Depress POWER 1 switch on.

C. Set ENERGY SELECT 2 switch to 360 or 400J.

D. Depress CHARGE 3 pushbutton and when instrument is in ready state, discharge the energy.

E. Verify that the TEST LOAD display appears.

F. Repeat steps A through E above, at 100J. Verify that the TEST LOAD display appears.

G. If the system fails this test, recalibrate as described in para. 4-53.

H. If OK, depress POWER 1 switch off.

4-53 Test Load Calibration.

A. Place paddles in Test Load holder on instrument. (Firmly press down.)

B. Depress POWER 1 switch on.

C. Set ENERGY SELECT 2 switch to 360 or 400J.

D. Depress CHARGE 3 pushbutton and when instrument is in the ready state, discharge the energy.

E. Check that the AVAILABLE ENERGY display indicates 366 or 406J.

F. Adjust R57 to obtain correct reading if necessary.

G. Remove the jumper at J10 pins 7-8. Place jumper on J10 pins 5-6 for 360J units.

H. Charge unit to 100J, and discharge. Check that the AVAILABLE ENERGY display is the same as the selected energy (100J).

I. Repeat for 360J (or 400J). Check that available energy is equal to the selected energy.

J. Select 200J and verify that this does not show on the display.

K. Verify that the TEST LOAD indicator operates. Switch POWER 1 off.

L. Restore jumpers to their original positions on J10.

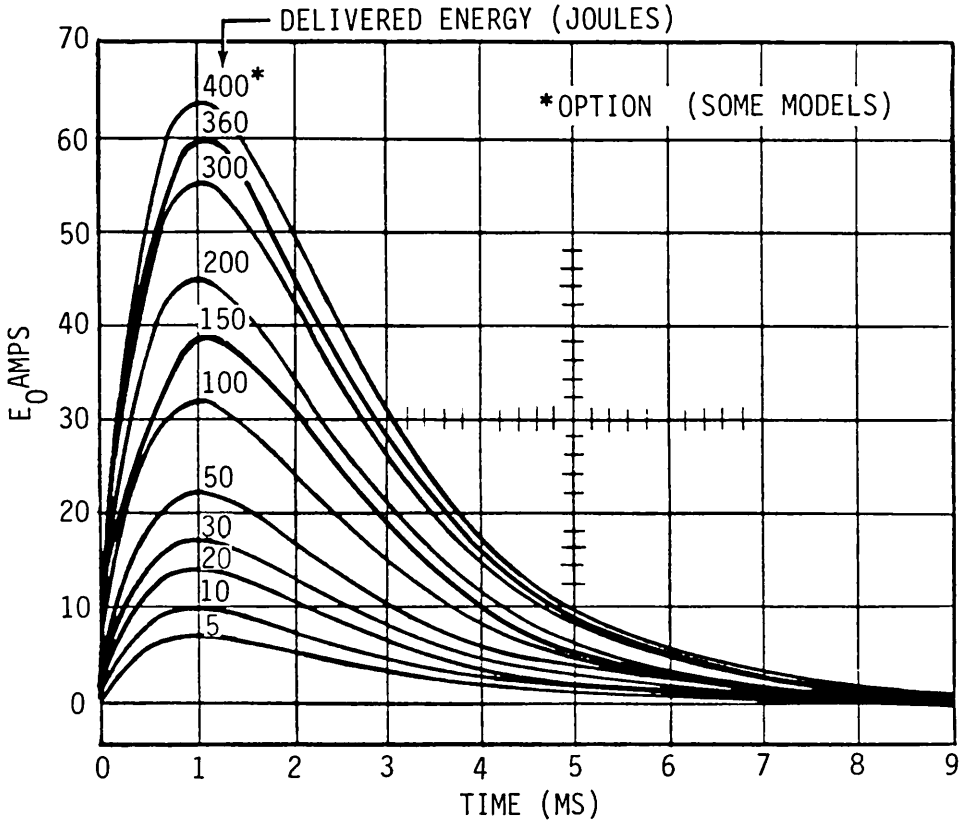


FIGURE 4-8. DC DEFIBRILLATOR OUTPUT WAVEFORMS

4-54. Synchronizer Test.

A. Combine the ECG Monitor unit and Defibrillator unit.

B. Connect a 1mV ECG signal to the patient cable input of the ECG Monitor unit.

C. Switch on the ECG Monitor unit and adjust the ECG SIZE control and QRS VOL control to obtain an audible beep tone with each QRS waveform.

D. Switch on Defibrillator power and check that the SYNC indicator is off.

E. Depress the SYNC pushbutton on and check that the SYNC indicator blinks off momentarily with each R-wave on the CRT of ECG Monitor. Verify that the trace on the Monitor CRT has a "bright-up" blip.

F. Turn the Defibrillator power off and on again. The SYNC indicator should remain off when power is reapplied and the "bright-up" blip on the Monitor (CRT) should not be present.

G. With the Defibrillator power on, set the ENERGY SELECT 2 switch to 50 joules. Charge the Defibrillator and discharge unit into the Energy Test Meter to insure proper operation.

H. Depress the SYNC pushbutton on. Charge the Defibrillator to 50 joules and depress the Paddle Discharge Pushbuttons. Discharge should only occur when the SYNC indicator signals R-wave detection.

I. Check that the SYNC indicator has turned off after the energy discharge.

J. With the instrument in the SYNC mode (SYNC indicator on), slide apart the ECG Monitor unit and Defibrillator unit. Verify that the SYNC indicator turns off and that the "bright-up" blips disappear on the ECG Monitor CRT.

K. Verify that the SYNC indicator cannot be turned on when the units are separated.

4-55. Microcomputer Check. The 6805R2 microcomputer has its own self-check feature which cycles each time the Defibrillator Unit is turned on.

A. Observe the red LED in the lower left hand corner of the Main Defib PCB Assembly.

B. Turn on the POWER 1 switch.

C. The LED should be on for about one second and then should be off, signifying that the self-test feature has cycled and the microcomputer is OK.

D. If the LED is permanently on, there is a fault in the microcomputer. Turn off the Defibrillator Unit.

E. Check U9 pin 11. Turn the Defibrillator Unit back on. There should be +5V on pin 11 for about one second, on power up, then pin 11 goes low.

F. If this test is OK, check the LED itself, or the LED Driver Transistor Q18. Either may be faulty.

G. Check pin 37 on U1 for a 1kHz pulse, (reset signal).

H. Check power supply to the microcomputer. If OK refer to Troubleshooting, Table 4-5.

4-56. Major Component Removal and Installation. The following procedures provide the sequence for removing and installing the major components of the DC Defibrillator.

CAUTION

Disconnect AC power cord from the AC (Mains) power source before attempting any disassembly procedure. The POWER 1 switch must be turned off and the Paddles disconnected from the connector on the instrument.

Installation is for the most part the opposite of removal therefore only removal procedures are provided. Special installation notes as required are provided as part of the removal or disassembly procedure. Disassemble only to the extent required. Figure 4-8 provides an exploded view of the DC Defibrillator to assist in the following procedure.

WARNING

KEEP HANDS CLEAR OF HAZARDOUS AREAS. Before removing upper case, observe location of Charge Storage Capacitor 12 , Inductor 18 and Transfer Relay 6 .

4-57. Upper and Lower Case Separation. Refer to Figure 4-9 and proceed as follows:

A. Remove sixteen screws 1 securing Upper Case 2 to Lower Case 3 . Note different lengths of screws. Use caution when re-inserting screws.

B. Carefully lift upper case 2 straight up until the screw and nut securing the Interconnect Assy 22 to the upper case 2 is fully exposed. Remove screw 19 and nut. Remove the interconnect assy from the upper case.

C. Disconnect connectors from J1, J4 and J9 on Main Defibrillator PCB 4 .

D. Carefully lift Upper Case 2 straight up and to the left side of the Lower Case. The Wiring Harness and Flex Cable will keep the two halves from being able to be pulled completely apart.

E. USING A 20K, 20W RESISTOR ON THE END OF HIGH VOLTAGE PROBE, INSURE THAT THE CHARGE STORAGE CAPACITOR IS DISCHARGED.

F. If further disassembly is required proceed to the applicable paragraph.

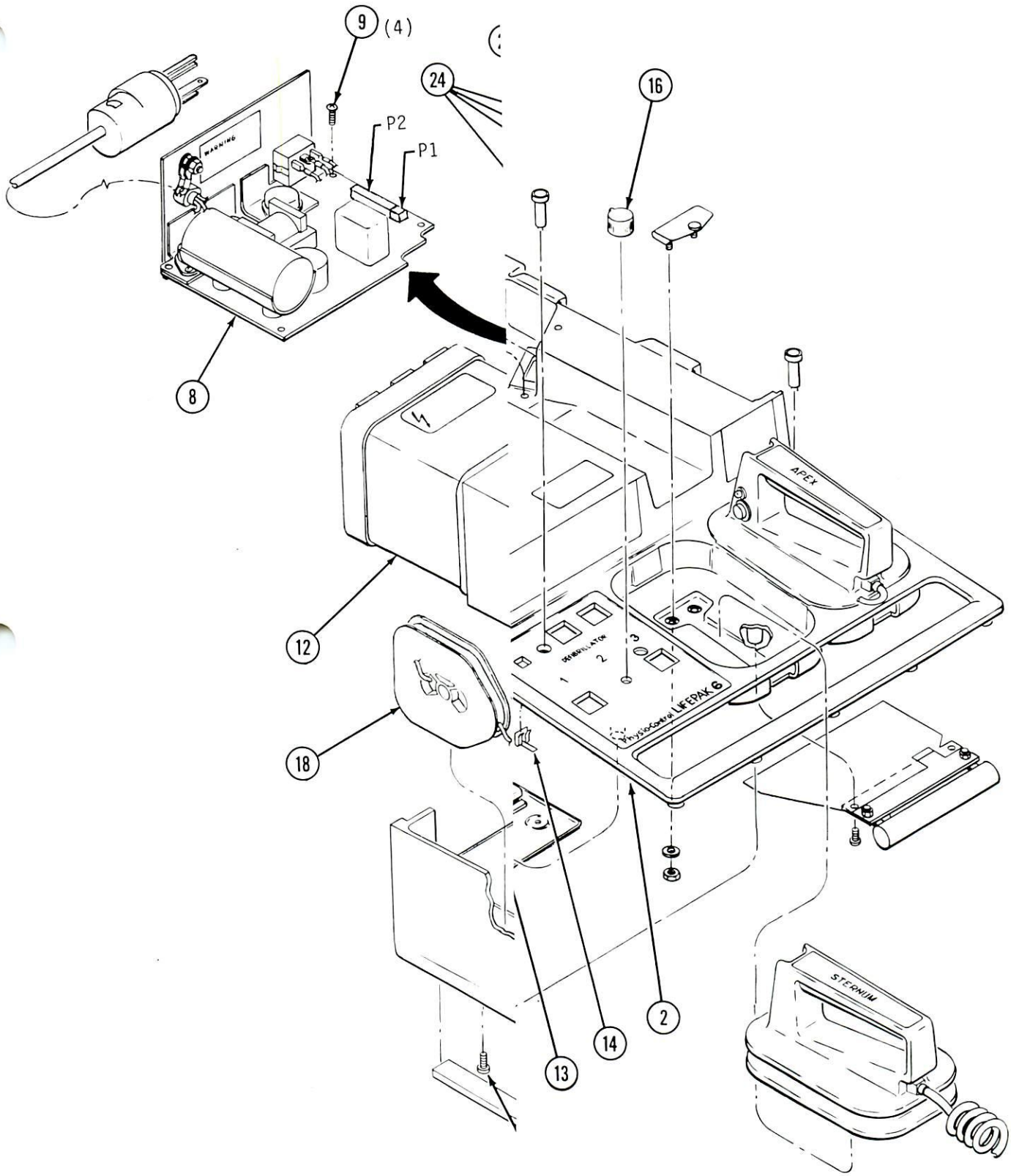


FIGURE 4-9. DC DEFIBRILLATOR MAJOR COMPONENT REMOVAL

4-58. Main Defibrillator PCB Removal. After completing the procedures of paragraph 4-57, to remove the Main Defibrillator PCB 4 , disconnect five connectors (P2,P3,P5,P6 and P7) from the PCB. Remove seven screws 5 securing PCB to case. Lift up Main Defibrillator PCB 4 from case and remove from instrument.

4-59. Relay Assembly Removal. To remove Relay Assembly 6 , disconnect the slide-on wire clips 20 (14 places) connected to terminals. Remove four screws 7 securing Relay Assembly to instrument and lift unit up and out of instrument.

CAUTION

When lifting Relay Assembly 6 out of the instrument, be careful not to rub the relay contacts on the sides of the interior instrument wall casing.

4-60. Defibrillator Charger PCB Removal. To remove the Defib Charger PCB 8 , lift paddle connector 11 up and to the side of instrument. Lift up and out bracket 10 . Remove connector P1 and P2 from PCB. Remove four screws 9 securing PCB to case. Lift the Defib Charger PCB 8 up and out of instrument.

NOTE: This assembly includes the power cord (or appliance connector) and heat sink assembly.

4-61. Appliance Connector Removal. To remove the Appliance Connector Assembly 23 , disconnect the four connections 24 , freeing the heat sink and Appliance Connector from the Defib Charger PCB 8 . Remove two nuts 25 and two washers 26 from heat sink 28 . Separate the heat sink from the Appliance Connector Assembly by removing four retaining screws 27 .

WARNING

THE FOLLOWING PRECAUTIONS SHOULD BE TAKEN:

A. Before removing components or disconnecting the Main Defibrillator PCB Assembly (801820), disconnect the Lifepak 6s Defibrillator Unit from the AC power supply. Disconnect the battery connection (P1 of B1) from the Defibrillator Charger PCB (J1 of A2).

B. Discharge the main defibrillator capacitor (C1) using an insulated resistor 5K to 20K ohm, 50W, 5KV. The resistor should be connected during all work on the Lifepak 6s Defibrillator Unit, until the Unit is ready to operate. The probe or slips used to connect the resistor should be insulated to withstand 20KV.

4-62. Charge Storage Capacitor Removal. To remove the Charge Storage Capacitor 21 , disconnect the four slide-on wire clips 21 connected to terminals and lift unit up and out of the Main Assembly. It is not necessary to remove the resistor bridge assembly.

4-63. Control Panel Assembly Removal. Remove the Control Panel Assembly 13 by removing clip 14 from the battery condition indicator. Remove knob 16 and three screws 15 securing the Control Panel to the case. Lift the Control Panel Assembly up and out of instrument while disconnecting the battery charge indicator.

4-64. Battery Pak Removal. To remove the Battery Pak 17 , cut the battery harness tie wraps. Disconnect the connector from the Main Harness Assembly then lift the unit up and out of instrument.

4-65. BATTERY MAINTENANCE GUIDE

Paragraphs 4-65 and 4-66 are a guide for maintaining the sealed nickel-cadmium battery system used in the LP6s cardiac care system. The information is provided to help identify and diagnose problems relating to the battery.

4-66. Failure Modes. The failures that occur in multi-cell batteries will generally fall into one of the following categories:

A. High or low resistance internal shortcircuits. Internal cell shortcircuits may appear as high or low resistances depending upon the degree and nature of the failure. A cell with a low resistance shortcircuit will not accept a normal charge and will have negligible or no voltage immediately after taking it off charge. A high resistance shortcircuit may accept some charge, but will cause the cell to internally discharge at a higher than normal rate when it is taken off charge. Both types are permanent failures and the battery should be replaced as soon as possible.

There are several adverse conditions which may contribute to internal shortcircuit. Most of these failures occur in multi-cell batteries which have been fully exhausted. Although exhausting a battery will not necessarily cause a shortcircuit, one may develop because there may not be enough internal energy in the battery to burn the shortcircuit away before it is fully established. The chances of incurring permanent damage are increased as the current, (below cut-off), the ambient temperature, and the time before recharging is increased. Charging at high rates and/or ambient temperature extremes may also cause internal cell shorts, but this occurs less often and can usually be identified if there is an electrolyte residue from the cell vents.

B. Excessive electrolyte loss. As a nickel-cadmium cell loses electrolyte, its internal resistance will begin to increase, thus causing a greater drop in the terminal voltage under load. If a sufficient quantity of electrolyte is lost, the cell will also suffer some loss in electrical storage capacity which will be permanent. A cell may lose a small quantity of electrolyte without adversely affecting its performance and may be considered serviceable.

C. Reduction in capacity and/or voltage. A more ambiguous type of failure concerns degradation in capacity and/or terminal voltage. This may be either permanent or temporary and its cause is more difficult to determine. Capacity and terminal voltage reduction will occur at the normal end-of-life of a cell or as a result of excessive electrolyte loss. They may also be temporarily reduced by charging at ambient temperature extremes, or resulting from a phenomenon known as "memory".

Both the latter conditions are reversible and can be corrected by charging at room temperature or with the Reconditioning Charge/Discharge Cycle described in paragraph 4-67.

There are two types of "memory" which may occur in sealed nickel-cadmium batteries; one affects capacity and the other affects terminal voltage. The only form of "memory" which is likely to affect batteries in Physio-Control products is the type which causes a slight reduction in terminal voltage. In this case, only the terminal voltage is lowered, usually only by about 20mV per cell. This type of memory will usually not cause a noticeable decrease in the operating time of an instrument, but may cause battery voltage indicators to falsely indicate a low battery condition.

Voltage "memory" is primarily caused by long term, sustained charge rates (C/10 and C/3), and its magnitude is a function of the battery temperature, charge rate and time. A battery is considerably more susceptible to "memory" if it is charged in a 45°C ambient environment than it would be if it were charged in a 25°C environment. The best way to prevent this trouble is to avoid charging the battery in hot environments or for extended periods of time.

4-67. Troubleshooting. Battery failures which render the instrument fully or partially inoperative usually involve a dramatic decrease in terminal voltage. In some cases, there may be little or no reduction in measured capacity, even though there may be a loss in operating time. If, for instance, the battery was charged in a high ambient temperature, it may suffer a reduction in both voltage and capacity. This may not appear during subsequent testing because it is a temporary result of adverse charging conditions. It will correct itself when the battery is charged at normal room temperature or if the charge current is reduced. This will be even more evident in instruments which have tightly enclosed batteries or poor thermal transfer.

Charger and equipment malfunctions may cause a reduction in actual capacity or there may be an apparent loss in capacity because of an erroneous battery level indicator. First identify the malfunction and then determine the cause. In many cases the battery failures are either directly caused or aggravated by adverse operating conditions or practices. Correcting these may prevent or at least delay recurrence of the malfunction.

When diagnosing battery performance problems, it is best to use a 1A constant current test load with a voltage threshold detector to terminate the discharge when cut-off is reached. Using this with a voltage recorder will eliminate load variations, protect the battery from accidental deep discharges and provide a profile record (see Figure 4-10) from which to evaluate subtle variations.

Performance evaluations should be done in an ambient temperature of 20° to 25°C to ensure accuracy.

Reconditioning Charge/Discharge Cycle.

1. Charge the battery at its normal rate.

2. Discharge the battery at C/5 to C rate (approximately 1A) while monitoring the terminal voltage for cut-off.

3. Recharge the battery at its specified overcharge rate (C/10 or 0.3C) in an ambient temperature of about 25°C.

4. Repeat steps 2 and 3.

This should erase any "memory" which may have developed. Compare the recorded voltage profiles for any difference in voltage or capacity.If the average voltage during the first discharge is slightly lower than that of the second discharge, then voltage "memory" was present. This affects only the voltage level and not the real capacity.

Since the average cell voltage is 1.2 - 1.35V, a 10-cell battery should have an average terminal voltage of 12 to 13.5V. If the voltage under a 1A load is 11.8V or less, one or more cells may be shorted. This is especially true if the voltage drop is in multiples of 1.2V.

If the voltage at a 1A discharge does not drop below 12V, or it fluctuates slightly, increase the discharge current by 1A or 2A and observe the terminal voltage.

If the voltage is now below 12V, the battery may have excessive internal resistance which will cause a greater voltage drop as the current is increased. If this creates a problem in the instrument, the battery should be replaced.

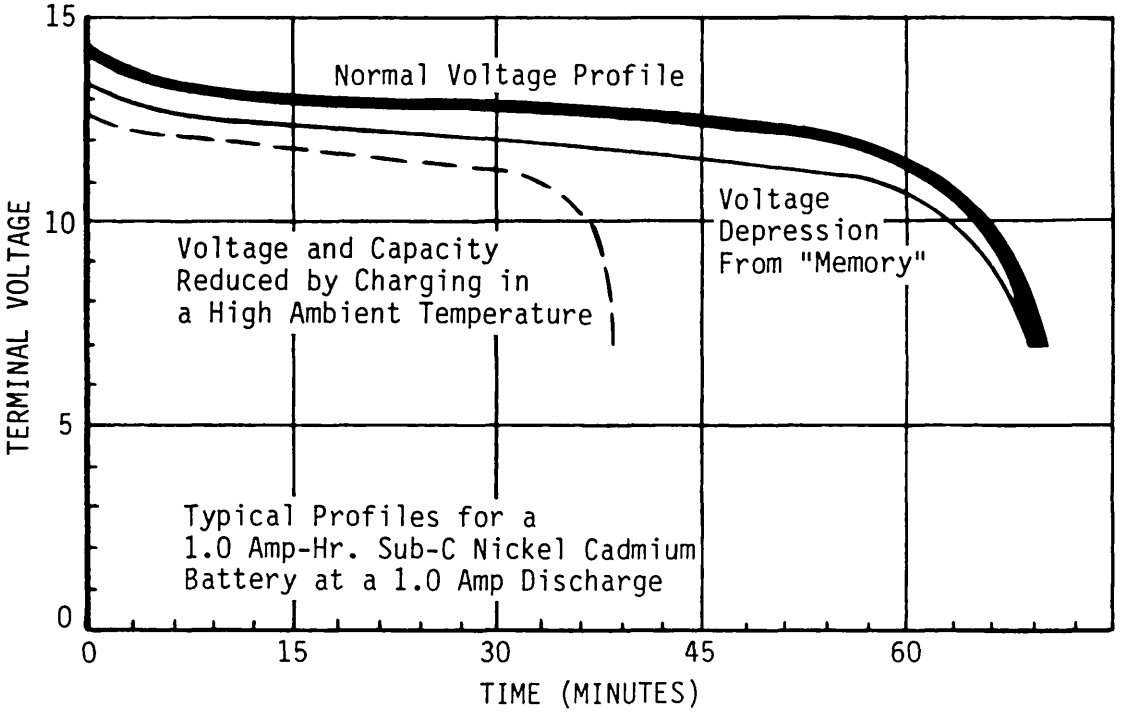


FIGURE 4-10. BATTERY VOLTAGE PROFILE

SECTION 5
ILLUSTRATED PARTS LISTS

5-1. GENERAL

This section provides the illustrated parts lists and describes the parts for LIFEPAK 6s instrument. Table 5-1 lists the parts lists and assembly drawings for the ECG Monitor and Table 5-2 lists the parts lists and assembly drawings for the DC Defibrillator.

5-2. Parts Lists.

1. FIG-ITEM This column contains the Figure Number or reference designator of the illustrated assembly and the assigned item number for each part.

2. PART NUMBER The Physio-Control Corporation or standard part number is contained in this column for each part lists.

3. DESCRIPTION This column contains the nomenclature and descriptive information for each part listed. Electrostatic Sensitive Devices (ESDs) are identified in this column by this symbol

(special handling of PCB assemblies containing ESDs is required).

4. USE CODE This column contains an alphabetical code which indicates configuration differences. Consult the first entry in the parts list for code effectivity.

5. QTY This column lists the total quantity of parts for each particular assembly. The abbreviation "REF" (reference) indicates that the part has been listed for reference purposes.

5-3. Part Ordering. Some parts may be purchased locally. When ordering from Physio-Control Corporation, give the instrument model number and serial number. Include information listed in the parts list under headings: FIG-ITEM, PART No., DESCRIPTION. Also include component values. Different parts may be substituted by Physio-Control to reflect modifications and improvements of instrument circuitry.

TABLE 5-1

ECG MONITOR PARTS LIST AND ASSEMBLY DRAWINGS

DRAWING NO.	NOMENCLATURE	FIGURE NO.
801555	MONITOR FINAL ASSEMBLY	5-1
801521	MAIN PFC ASSEMBLY	5-2
801548	CONTROL PFC ASSEMBLY	5-3
800854	HIGH VOLTAGE PCB ASSEMBLY	5-4
801568	LOW VOLTAGE POWER SUPPLY/DEFLECTION AMP PCB ASSEMBLY	5-5
801445	SYSTOLE PROCESSOR PCB ASSEMBLY	5-6
800159	NO-FADE PCB ASSEMBLY	5-7
800157	CHARGER PCB ASSEMBLY, MONITOR	5-8
800101	PREAMP PCB ASSEMBLY	5-9A
801873	PREAMP PCB ASSEMBLY	5-9B
801584	RECORDER PCB ASSEMBLY	5-10
801904	DISPLAY PCB ASSEMBLY	5-11
800782	INTERCONNECT HARNESS ASSEMBLY	5-12A
802240	INTERCONNECT HARNESS ASSEMBLY	5-12B
801999	ECG PFC ASSEMBLY	5-13A
802193	ECG PFC ASSEMBLY	5-13B
801546	AAR LOGIC PCB ASSEMBLY	5-14
800632	CRT ASSEMBLY	5-15
800959	APPLIANCE CONNECTOR ASSEMBLY	5-16

TABLE 5-2

DC DEFIBRILLATOR PARTS LIST AND ASSEMBLY DRAWINGS

DRAWING NO.	NOMENCLATURE	FIGURE NO.
801585	DEFIBRILLATOR FINAL ASSEMBLY	5-17
801852	CONTROL PANEL/PFC ASSEMBLY	5-18
801851	CONTROL PANEL ASSEMBLY	5-19
801848	CONTROL PFC ASSEMBLY	5-20
801837	WIRING HARNESS ASSEMBLY	5-21
800041	CHARGER PCB ASSEMBLY, DEFIB	5-22A
801506	CHARGER ASSEMBLY, DEFIB	5-22B
800960	HEATSINK ASSEMBLY	5-23A
801563	HEATSINK ASSEMBLY	5-23B
801820	MAIN DEFIB PCB ASSEMBLY	5-24
801841	TEST LOAD PCB ASSEMBLY	5-25
800250	PADDLES ASSEMBLY	5-26
801843	ENERGY METER PCB ASSEMBLY	5-27

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PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
1	801555-00	MONITOR, FINAL ASSY, 115V/60Hz, W/Rcdr, English	A	REF
	801555-01	MONITOR, F/A, 115V/60Hz, No/Rcdr, English	B	
	801555-02	MONITOR, F/A, 100V/50Hz, W/Rcdr, English	C	
	801555-03	MONITOR, F/A, 100V/50Hz, No/Rcdr, English	D	
	801555-04	MONITOR, F/A, 100V/60Hz, W/Rcdr, English	E	
	801555-05	MONITOR, F/A, 100V/60Hz, No/Rcdr, English	F	
	801555-06	MONITOR, F/A, 220V/50Hz, W/Rcdr, English	G	
	801555-07	MONITOR, F/A, 220V/50Hz, No/Rcdr, English	H	
	801555-08	MONITOR, F/A, 220V/60Hz, W/Rcdr, English	I	
	801555-09	MONITOR, F/A, 220V/60Hz, No/Rcdr, Engish	J	
	801555-10	MONITOR, F/A, 240V/50Hz, W/Rcdr, English	K	
	801555-11	MONITOR, F/A, 240V/50Hz, No/Rcdr, English	L	
	801555-18	MONITOR, F/A, 115V/60Hz, W/Rcdr, CSA,English	M	
	801555-19	MONITOR, F/A, 115V/60Hz, No/Rcdr,CSA,English	N	
	801555-20	MONITOR, F/A, 115V/60Hz, W/Rcdr, CSA,French	O	
	801555-21	MONITOR, F/A, 115V/60Hz, No/Rcdr,CSA,French	P	
	801555-22	MONITOR, F/A, 220V/50Hz, W/Rcdr, French	Q	
	801555-23	MONITOR, F/A, 220V/50Hz, No/Rcdr, French	R	
	801555-24	MONITOR, F/A, 220V/50Hz, W/Rcdr, German	S	
	801555-25	MONITOR, F/A, 220V/50Hz, No/Rcdr, German	T	
	801555-26	MONITOR, F/A, 115V/60Hz, W/Rcdr, Spanish	U	
	801555-27	MONITOR, F/A, 115V/60Hz, No/Rcdr, Spanish	V	
	801555-28	MONITOR, F/A, 220V/50Hz, W/Rcdr, Spanish	W	
	801555-29	MONITOR, F/A, 220V/50Hz, No/Rcdr, Spanish	X	
	801555-30	MONITOR, F/A, 220V/60Hz, W/Rcdr, Spanish	Y	
	801555-31	MONITOR, F/A, 220V/60Hz, No/Rcdr, Spanish	Z	
	801555-32	MONITOR, F/A, 115V/60Hz, A/C Only, W/Rcdr, English	AA	
	801555-33	MONITOR, F/A, 115V/60Hz, A/C Only, No/Rcdr, English	AB	
	801555-34	MONITOR, F/A, 115V/60Hz, W/Rcdr, English	AC	
	801555-35	MONITOR, F/A, 115V/60Hz, No/Rcdr, English	AD	
	801555-36	MONITOR, F/A, 115V/60Hz, UL,W/Rcdr,English	AE	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
	801555-37	MONITOR, Final Assy, 115V/60Hz, UL, No/Rcdr, English	AF	REF
	801555-38	MONITOR, F/A, 100V/50Hz, W/Rcdr,	AG	
	801555-39	MONITOR, F/A, 100V/50Hz, No/Rcdr, English	AH	
	801555-40	MONITOR, F/A, 100V/60Hz, W/Rcdr, English	AI	
	801555-41	MONITOR, F/A, 100V/60Hz, No/Rcdr, English	AJ	
	801555-42	MONITOR, F/A, 220V/50Hz, W/Rcdr, English	AK	
	801555-43	MONITOR, F/A, 220V/50Hz, No/Rcdr, English	AL	
	801555-44	MONITOR, F/A, 220V/60Hz, W/Rcdr, English	AM	
	801555-45	MONITOR, F/A, 220V/60Hz, No/Rcdr, English	AJ	
	801555-46	MONITOR, F/A, 240V/50Hz, W/Rcdr, English	AO	
	801555-47	MONITOR, F/A, 240V/50Hz, No/Rcdr, English	AP	
	801555-48	MONITOR, F/A, 240V/50Hz, BSI,W/Rcdr,English	AQ	
	801555-49	MONITOR, F/A, 240V/50Hz, BSI,No/Rcdr,English	AR	
	801555-50	MONITOR, F/A, 115V/60Hz, W/Rcdr,CSA,English	AS	
	801555-51	MONITOR, F/A, 115V/60Hz, No/Rcdr,CSA,English	AT	
	801555-52	MONITOR, F/A, 115V/60Hz, W/Rcdr,CSA,French	AU	
	801555-53	MONITOR, F/A, 115V/60Hz, No/Rcdr,CSA,French	AV	
	801555-54	MONITOR, F/A, 220V/50Hz, W/Rcdr, French	AW	
	801555-55	MONITOR, F/A, 220V/50Hz, No/Rcdr, French	AX	
	801555-56	MONITOR, F/A, 220V/50Hz,HOMO,W/Rcdr,French	AY	
	801555-57	MONITOR, F/A, 220V/50Hz,HOMO,No/Rcdr,French	AZ	
	801555-58	MONITOR, F/A, 220V/50Hz, W/Rcdr, German	BA	
	801555-59	MONITOR, F/A, 220V/50Hz, No/Rcdr, German	BB	
	801555-60	MONITOR, F/A, 220V/50Hz,W/Rcdr,TUV,German	BC	
	801555-61	MONITOR, F/A, 220V/50Hz,No/Rcdr,TUV,German	BD	
	801555-62	MONITOR, F/A, 115V/60Hz, W/Rcdr, Spanish	BE	
	801555-63	MONITOR, F/A, 115V/60Hz, No/Rcdr, Spanish	BF	
	801555-64	MONITOR, F/A, 220V/50Hz, W/Rcdr, Spanish	BG	
	801555-65	MONITOR, F/A, 220V/50Hz, No/Rcdr, Spanish	BH	
	801555-66	MONITOR, F/A, 220V/60Hz, W/Rcdr, Spanish	BI	
	801555-67	MONITOR, F/A, 220V/60Hz, No/Rcdr, Spanish	BJ	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
	801555-68	MONITOR, F/A, 115V/60Hz, A/C Only,W/Rcdr, English	BK	REF
	801555-69	MONITOR, F/A, 115V/60Hz, A/C Only,No/Rcdr, English	BL	
2	800310-07	. . CASE ASSY, Lower		1
3	200318-015	. . TAPE, Neophrene		A/R
4	800316-00	. . FOOT, Mounting		1
5	800316-01	. . FOOT, Mounting		1
6	800316-02	. . FOOT, Mounting ---Attaching Parts		2
7	201102-068	. SCREW, 6-32 X 1/4, Binder Head ---*---		12
8	800308-19	. CASE ASSY, Upper	A-AB	1
	802233-02	. CASE ASSY, Upper (USE CODE Cont.) AE,AF,AG,AH,AI,AJ, AU,AV,AY,AZ,BE,BF,BK,BL	AC,AD, ←	
	802233-03	. CASE ASSY, Upper (USE CODE Cont.) AM,AN,AO,AP,AQ,AR, AW,AX,AY,AZ,BA,BB,BC,BD,BG,BH,BI,BJ	AK,AL, ←	
9	800317-00	. . HANDLE		1
10	800318-01	. . PLATE, Latch		1
11	800318-02	. . PLATE, Latch ---Attaching Parts		1
12	90-03021	. . KEPNUT, 6-32 X 1/4		3
13	200190-001	. . SCREW, 1/4-20 X 1/2, Fillister Head ---*---		4
A1	801521-00	. PFC ASSY, Main (See Figure 5-2) (USE CODE Cont.) I,K,M,O,Q,S,U,W,Y,AA, AC,AE,AG,AI,AK,AM,AO,AQ,AS,AU,AW,AY,BA, BC,BE,BG,BI,BK	AC,E,G, ←	1
	801521-01	. PFC ASSY, Main (USE CODE Cont.) J,L,N,P,R,T,V,X,Z,AB,AD, AF,AH,AJ,AL,AN,AP,AR,AT,AV,AX,AZ,BB,BD,BF, BH,BJ,BL	B,D,F,H, ←	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
14	802044-00	. . SHIELD, Nomex, Main PFC		1
A2	801548-00	. PFC ASSY, Control (See Figure 5-3) (USE CODE Cont.) I,K,M,O,Q,S,U,W,Y,AC,AE, AG,AI,AK,AM,AO,AQ,AS,AU,AW,AY,BA,BE,BG,BI	A,C,E,G, ←	1
	801548-02	. PFC ASSY, Control (USE CODE Cont.) J,L,N,P,R,T,V,X,Z,AD,AF, AH,AJ,AL,AN,AP,AR,AT,AV,AX,AZ,BB,BD,BF,BH, BJ	B,D,F,H, ←	
	801548-03	. PFC ASSY, Control	AA,BK	
	801548-04	. PFC ASSY, Control ---Attaching Parts	BL	
15	200162-001	. FASTENER, Right Angle ---*---		1
A3	800112-05	. POWER SUPPLY ASSY		1
16	800343-01	. . SHIELD, Power Supply		1
17	800854-00	. . PCB ASSY, High Voltage (See Figure 5-4)	ATTENTION	1
18	801568-01	. . PCB ASSY, Low Voltage Power Supply/ Deflection Amp (See Figure 5-5) ATTENTION ---Attaching Parts		1
19	200475-262	. SCREW, 4-40 X .375L, Binder Head		6
20	201122-764	. SPACER, 4-40 X 1.000 ---*---		3
A4	801445-04	. PCB ASSY, Systole Processor(See Figure 5-6)	ATTENTION	1
A5	800159-04	. PCB ASSY, No Fade (See Figure 5-7) ATTENTION		1
A6	800157-07	. PCB ASSY, Charger (See Figure 5-8) (USE CODE Cont.) U,V,AC-AJ,AS-AV,BE,BF	A-F,M-P, ←	1
	800157-08	. PCB ASSY, Charger	AA,AB, BK,BL	
	800157-09	. PCB ASSY, Charger (USE CODE Cont.) W-Z,AK-AR,AW-BD,BG-BJ	G-L,Q-T, ←	
A7	800101-03	. PCB ASSY, Preamp (See Figure 5-9) ATTENTION (USE CODE Cont.) I,J,M-P,U,V,Y-AB	A,B,E,F, ←	1
	800101-04	. PCB ASSY, Preamp (USE CODE Cont.) K,L,Q-T,W,X	C,D,G,H, ←	
	801873-00	. PCB ASSY, Preamp ATTENTION (USE CODE Cont.) AI,AJ,AM,AN,AS-AV,BE, BF,BI-BL	AC-AF, ←	
	801873-01	. PCB ASSY, Preamp (USE CODE Cont.) AK,AL,AO-AR,AW-BD,BG,BH	AG,AH, ←	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
21	800402-03	. COVER, Preamp Top	A-AB	1
22	800402-02	. COVER, Preamp Bottom	A-AB	1
23	800838-00	. SHIELD, Preamp Dielectric	A-AB	1
	802200-00	. SHIELD, Preamp Dielectric (USE CODE Cont.) AG,AI,AK,AM,AO,AQ,AS, AU,AW,AY,BA,BC,BE,BG,BI,BK	AC,AE, ←	1
	802200-01	. SHIELD, Preamp Dielectric (USE CODE Cont.) AH,AJ,AL,AN,AP,AR,AT, AV,AX,AZ,BB,BD,BF,BH,BJ ---Attaching Parts	AD,AF, ←	
24	200191-048	. STANDOFF, 6-32 X .812, F/F		2
25	800446-01	. STANDOFF, 6-32 X .375, M/M	A-AB	2
	201446-002	. STANDOFF, 6-32 X .250, M/M	AC-BL	1
26	201113-036	. SCREW, 4-40 X .250, Round Head		1
27	90-03043	. HEXNUT, 4-40 X .250, Nylon		1
28	90-03021	. KEPNUT, 6-32 X .250 ---*---		2
A8	801862-00	. RECORDER ASSY (USE CODE Cont.) I,K,M,O,Q,S,U,W,Y,AA, AC,AE,AG,AI,AK,AM,AO,AQ,AS,AU,AW,AY,BA, BC,BE,BG,BI,BK	A,C,E,G, ←	1
29	801717-00	. . RECORDER		1
30	801584-00	. . PCB ASSY, Recorder (See Figure 5-10)		1
31	800972-00	. . LABEL, Paper Loading		1
32	801863-01	. PLATE, Recorder Mounting (USE CODE Cont.) J,L,N,P,R,T,V,X,Z,AB	B,D,F,H, ←	1
	801863-07	. PLATE, Recorder Mounting (USE CODE Cont.) AG,AI,AK,AM,AO,AQ,AS, AU,AW,AY,BA,BC,BE,BG,BI,BK	AC,AE, ←	
	801863-05	. PLATE, Recorder Mounting (USE CODE Cont.) I,K,M,O,Q,S,U,W,Y,AA	A,C,E,G, ←	
	801863-09	. PLATE, Recorder Mounting (USE CODE Cont.) AG,AI,AK,AM,AO,AQ,AS,AU, AW,AY,BA,BC,BE,BG,BI,BK ---Attaching Parts	AD,AE, ←	
33	200475-292	. SCREW, 6-32 X .250L, Binder Head		3
34	90-04045	. LOCKWASHER, #6 X .315 OD/.020 T		3
35	200302-034	. STANDOFF, 6-32 X 1.250, M/F ---*---		2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
36	200302-090	. STANDOFF, 6-32 X 3.0, M/F		1
A9	801904-00	. PCB ASSY, Display (See Figure 5-11) ---Attaching Parts		1
37	200475-260	. SCREW, 4-40 X .250 L, Binder Head	A-AB	1
	200476-760	. SCREW, 4-40 X .250 L, Pan Head	AC-BL	
38	90-04066	. WASHER, Flat, #4 X .250 OD	AC-BL	1
39	201118-037	. SPACER, 4-40 X .562	A-AB	1
	90-02008	. SPACER, #4 X .500	AC-BL	
40	201105-538	. SCREW, 4-40 X .375, Flat Head ---*---		1
A10	800782-03	. HARNESS, Interconnect Assy(See Figure 5-12)	A-F,M-P,U,V,AA,AB	1
	800782-04	. HARNESS, Interconnect Assy	G-L,Q-T,W-Z	
	802240-00	. HARNESS, Interconnect Assy ---Attaching Parts	AC-BL	
41	200475-291	. SCREW, 6-32 X .187, Binder Head ---*---		1
A11	800357-02	. TRANSFORMER ASSY (USE CODE Cont.) AA,AB,AC-AF,BE,BF,BK,BL	A,B,U,V, ←	1
	800357-03	. TRANSFORMER ASSY (USE CODE Cont.) W-Z,AK-AR,AW-BD,BG-BJ	G-L,Q-T, ←	
	800357-04	. TRANSFORMER ASSY	M-P,AS-AV	
	800779-00	. TRANSFORMER ASSY	C-F,AG-AJ	
42	200318-017	. TAPE, Sponge, Adhesive		A/R
43	802368-00	. INSULATOR, Transformer, CSA	AC-BL	1
A12	800356-05	. POWER CORD ASSY (USE CODE Cont.) U,V,AA-AJ,AS-AV,BE,BF,BK,BL	A-F,M-P, ←	1
44	200150-000	. . STRAIN RELIEF		1
A13	801999-00	. PFC ASSY, ECG (See Figure 5-13)	A-AB	1
	802193-00	. PFC ASSY, ECG	AC-BL	
45	801419-00	. SHIELD, ECG Circuit	A-F	1
	801419-01	. SHIELD, ECG Circuit	A-AB	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
A14	801546-00	. PCB ASSY, AAR Logic (See Figure 5-14) (USE CODE Cont.) I,K,M,O,Q,S,U,W,Y,AA,AC, AE,AG,AI,AK,AM,AO,AQ,AS,AU,AW,AY,BA,BC, BE,BG,BI,BK ---Attaching Parts	A,C,E,G, ←	1
46	200475-260	. SCREW, 4-40 X 1/4, Binder Head ---*---		3
A15	800632-00	. CRT ASSY		1
47	801037-01	. . SHIELD ASSY, CRT Radiation	G,Q-T, W-Z,AG-BJ	1
48	800959-01	. . CONNECTOR ASSY, Appliance (USE CODE Cont.) W-Z,AK-AR,AW-BD,BG-BJ	G-L,Q-T, ←	1
49	200619-008	. . FUSE, Slo/Bl, .2A/250V ---Attaching Parts		2
50	200497-014	. SCREW, 6-32 X 375, Flat Head ---*---		2
51	800285-01	. BATTERY PAK		1
52	90-08010	. TAPE, Foam, 1/8 X 1		A/R
53	800014-02	. CABLE, Flat		1
54	200810-000	. COVER, Phone Jack Connector		1
55	200130-003	. LED, 2.4Vdc, 20mA, Green		1
56	200126-006	. KNOB, Instrumentation		1
57	200304-000	. KNOB, Instrumentation		2
58	200126-000	. KNOB, Instrumentation	A-AB	3
	200126-000	. KNOB, Instrumentation	AC-BL	2
	201432-000	. KNOB, Instrumentation	AC-BL	1
59	800372-01	. SWITCH, Pushbutton (Power)	A-AT,BK, BL	1
	800372-03	. SWITCH, Pushbutton (Power)	AU-BJ	
60	800313-03	. BEZEL, Monitor ---Attaching Parts		1
61	201105-538	. . SCREW, 4-40 X .375, Flat Head		3
62	200478-760	. . SCREW, 4-40 X .250, Flat Head		2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
63	201105-544	. . SCREW, 4-40 X .750, Flat Head		2
64	200478-766	. . SCREW, 4-40 X .625, Flat Head ---*---		1
65	800315-04	. FRONT PANEL	A-N,AA-AT,BK,BL	1
	800315-08	. FRONT PANEL	S,T,BA-BD	
	800315-09	. FRONT PANEL	U-Z,BE-BJ	
	800315-21	. FRONT PANEL	O-R,AU-AZ	
66	801918-00	. LABEL, Control, W/Rcdr, English	A,M	1
	801918-01	. LABEL, Control, No/Rcdr, English	B,N	
	801918-02	. LABEL, Control, W/Rcdr, French	O,Q	
	801918-03	. LABEL, Control, No/Rcdr, French	P,R	
	801918-04	. LABEL, Control, W/Rcdr, German	S	
	801918-05	. LABEL, Control, No/Rcdr, German	T	
	801918-06	. LABEL, Control, W/Rcdr, Spanish	U,W,Y	
	801918-07	. LABEL, Control, No/Rcdr, Spanish	V,X,Z	
	801918-08	. LABEL, Control, W/Rcdr, English, Int'l	C,E,G,I,K	
	801918-09	. LABEL, Control, No/Rcdr, English, Int'l	D,F,H,J,L	
	801918-10	. LABEL, Control, A/C Only, W/Rcdr, English	AA	
	801918-11	. LABEL, Control, A/C Only, No/Rcdr, English	AB	
	801918-12	. LABEL, Control, W/Rcdr, English	AC,AE,AS	
	801918-13	. LABEL, Control, No/Rcdr, English	AD,AF,AT	
	801918-14	. LABEL, Control, W/Rcdr, French	AU,AW,AY	
	801918-15	. LABEL, Control, No/Rcdr, French	AV,AX,AZ	
	801918-16	. LABEL, Control, W/Rcdr, German	BA,BC	
	801918-17	. LABEL, Control, No/Rcdr, German	BB,BD	
	801918-18	. LABEL, Control, W/Rcdr, Spanish	BE,BG,BI	
	801918-19	. LABEL, Control, No/Rcdr, Spanish	BF,BH,BJ	
	801918-20	. LABEL, Control, W/Rcdr, English, Int'l	AG,AI,AK,AM,AO,AQ	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
	801918-21	. LABEL, Control, No/Rcdr, English, Int'l	AH,AJ, AL,AN, AP,AR	
	801918-22	. LABEL, Control, A/C Only, W/Rcdr, English	BK	
	801918-23	. LABEL, Control, A/C Only, No/Rcdr, English	BL	
67	800504-03	. LABEL, ECG Output, English	A-L,AA-AR,BK,BL	1
	800504-04	. LABEL, ECG Output, French	Q,R	
	800504-05	. LABEL, ECG Output, German	S,T,BA-BD	
	800504-06	. LABEL, ECG Output, Spanish	U-Z,BE-BJ	
	800505-04	. LABEL, ECG Output, French	AW-AZ	
	801339-00	. LABEL, ECG Output, CSA, English/French	M-P,AS-AV	
68	801533-00	. LABEL, High Voltage, English, French, German, Spanish		1
69	801919-00	. LABEL, Operating Instructions, W/Rcdr, English	A,M,AA, AC,AE, AS,BK	1
	801919-01	. LABEL, Operating Instructions, No/Rcdr, English	B,N,AB, AD,AF, AT,BK	
	801919-02	. LABEL, Operating Instructions, CSA, W/Rcdr, French	O,AU	
	801919-03	. LABEL, Operating Instructions, CSA,No/Rcdr, French	P,AV	
	801919-04	. LABEL, Operating Instructions, W/Rcdr, French	Q,AW,AY	
	801919-05	. LABEL, Operating Instructions, No/Rcdr, French	R,AX,AZ	
	801919-06	. LABEL, Operating Instructions, W/Rcdr, German	S,BA,BC	
	801919-07	. LABEL, Operating Instructions, No/Rcdr, German	T,BB,BD	
	801919-08	. LABEL, Operating Instructions, W/Rcdr, Spanish	U,Y,BE, BI	
	801919-09	. LABEL, Operating Instructions, No/Rcdr, Spanish	V,X,BF, BH	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
	801919-10	. LABEL, Operating Instructions, W/Rcdr, Spanish	W,BG	
	801919-11	. LABEL, Operating Instructions, No/Rcdr, Spanish	Z,BJ	
	801919-12	. LABEL, Operating Instructions, W/Rcdr, English (USE CODE Cont.) K,AG,AI,AK,AM, AO,AQ	C,E,G,I, ←	
	801919-13	. LABEL, Operating Instructions, No/Rcdr, English (USE CODE Cont.) L,AH,AJ,AL,AN, AP,AR	D,F,H,J, ←	
70	801917-00	. LABEL, Logo, English	A-N,AA-AT,BK,BL	1
	801917-01	. LABEL, Logo, French	O-R,AU-AZ	
	801917-02	. LABEL, Logo, German	S,T,BA-BJ	
	801917-03	. LABEL, Logo, Spanish	U-Z	
71	800896-04	. LABEL, Serial Number, CSA, French	O,P,AU, AV	1
	800896-05	. LABEL, Serial Number, French	Q,R,AW-AZ	
	800896-06	. LABEL, Serial Number, German	S,T,BA-BD	
	800896-07	. LABEL, Serial Number, 220/240V, Spanish	W-Z,BG-BJ	
	800896-08	. LABEL, Serial Number, 117V, Spanish	U,V,BE, BG	
	800896-10	. LABEL, Serial Number, Int'l, English	C-L,AK-AR	
	800896-11	. LABEL, Serial Number, English	A,B,AA-AJ,BK	
	800896-12	. LABEL, Serial Number, CSA, English	M,N,AS, AT	
72	800944-00	. LABEL, Mains Power, English	G-L,AK-AR	1
	800944-03	. LABEL, Mains Power, French	Q,R,AW-AZ	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-1				
	800944-04	. LABEL, Mains Power, German	S,T,BA-BD	
	800944-05	. LABEL, Mains Power, Spanish	W-Z,BG-BJ	
73	800943-02	. LABEL, Earth Ground, Symbol		1
74	801362-03	. LABEL, Fuse Warning		1
75	800943-09	. LABEL, High Voltage	AC-BL	1
76	800360-05	. LABEL, Warning, CSA, English	M,N	1
	800360-06	. LABEL, Warning, CSA, French	O,P	
77	800942-00	. LABEL, Input Fuse, 220V/50Hz, English	G,H,W,Z, AK,AL, BG,BH	1
	800942-01	. LABEL, Input Fuse, 240V/50Hz, English	K,L,AO, AP,AQ,AR	
	800942-02	. LABEL, Input Fuse, 220V/60Hz, English	I,J,X,Y, AM,AJ, BI,BJ	
	800942-03	. LABEL, Input Fuse, 220V/50Hz, French	Q,R,AW, AX,AY, AZ	
	800942-04	. LABEL, Input Fuse, 220V/50Hz, German	S,T,BA, BB,BC, BD	

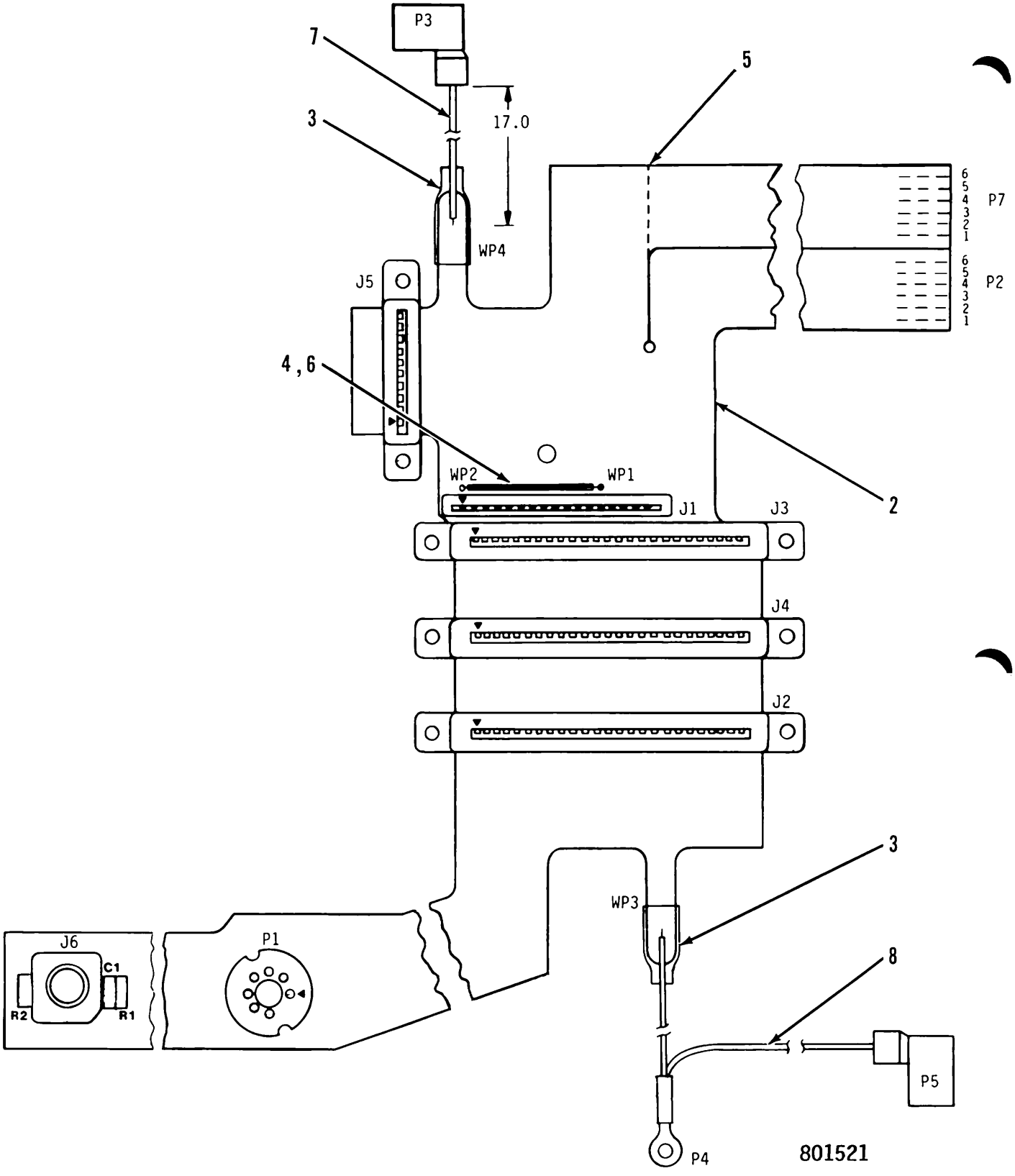


FIGURE 5-2. MAIN PFC ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-2				
A1	801521-00	PFC ASSY, Main	A	REF
	801521-01	PFC ASSY, Main	B	
2	801520-02	. CIRCUIT, Printed Flex		1
C1	200049-039	. CAPACITOR, .1µf/50V		1
J1	200073-011	. CONNECTOR, Plug		1
J2-J4	200101-004	. CONNECTOR, Receptacle		3
J5	200101-000	. CONNECTOR, Receptacle		1
J6	200136-000	. CONNECTOR, Receptacle, Phone Jack		1
P1	800373-00	. CONNECTOR, Receptacle, 7-contact		1
P3	200514-000	. TERMINAL, Quick Disconnect		2
P4	200276-207	. TERMINAL, Ring Lug		1
P5		. (Same As P3)		
R1	200054-193	. RESISTOR, 1 K, 1/8W, 1%		1
R2	200054-480	. RESISTOR, 1 M, 1/8W, 1%		1
3	200283-004	. TUBING, Heat Shrink		A/R
4	200624-004	. TUBING, Teflon, .027 ID, Thin Wall	A	A/R
5	200283-008	. TUBING, Heat Shrink	B	A/R
6	90-09138	. WIRE, Solid Bus, AWG #22	A	A/R
7	200357-056	. WIRE, Stranded, #18, CSA, Red		A/R
8	200357-272	. WIRE, Stranded, #18, CSA, Grn/Yel		A/R

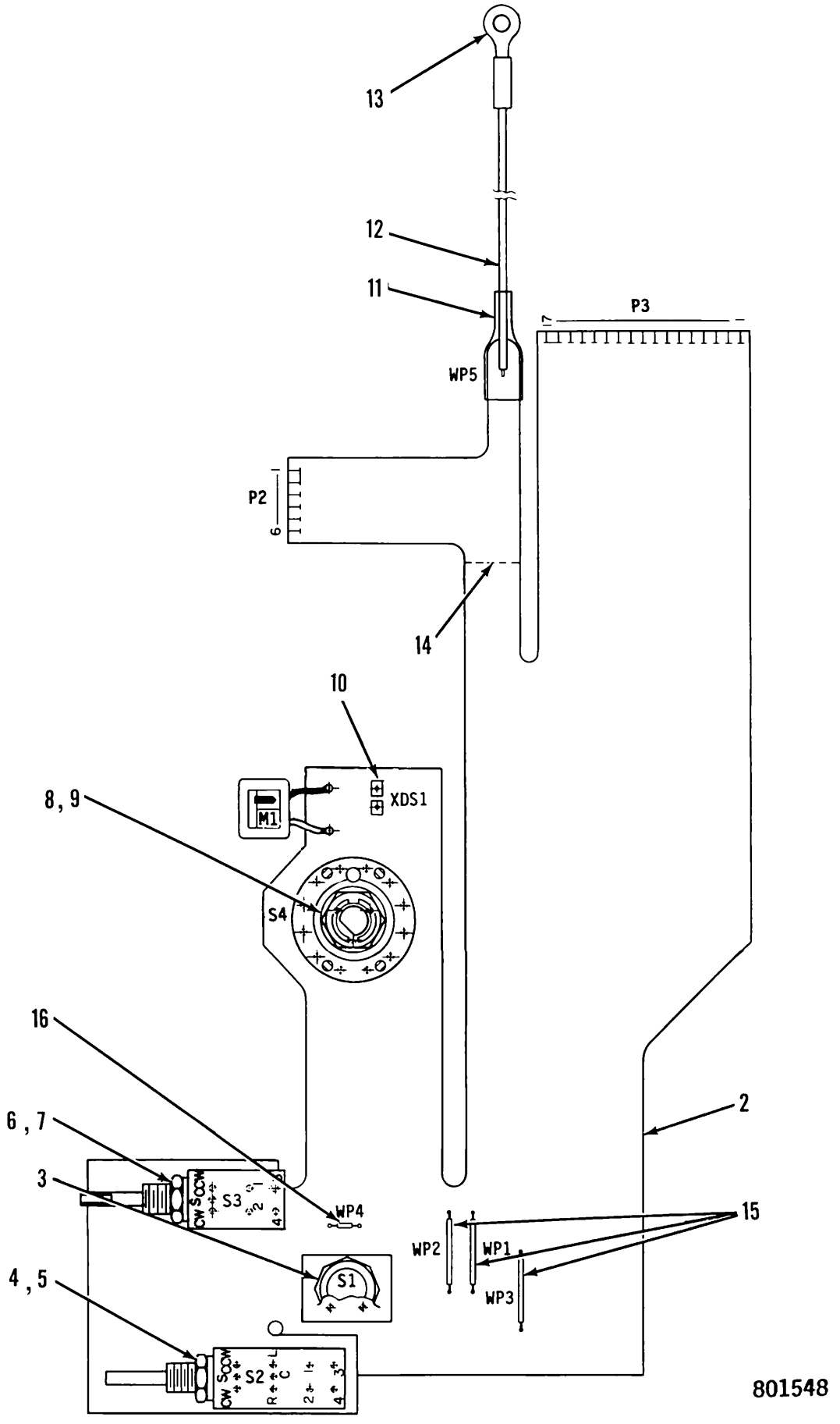


FIGURE 5-3. CONTROL PFC ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-3				
A2	801548-00	PFC ASSY, Control	A	REF
	801548-02	PFC ASSY, Control	B	
	801548-03	PFC ASSY, Control	C	
	801548-04	PFC ASSY, Control	D	
2	801547-02	. CIRCUIT, Printed Flex		1
M1	200129-001	. METER, Indicator	A,B	1
S1	800526-00	. SWITCH, Pushbutton ---Attaching Parts		
3	NO NUMBER	. LOCKNUT ---*---		1
S2	801906-00	. SWITCH, Rotary Pot ---Attaching Parts		1
4	NO NUMBER	. LOCKWASHER		1
5	NO NUMBER	. NUT ---*---		1
S3	800264-01	. SWITCH, Pot ---Attaching Parts		1
6	NO NUMBER	. LOCKWASHER		1
7	NO NUMBER	. NUT ---*---		1
S4	801905-00	. SWITCH, Rotary ---Attaching Parts	A,C	1
8	NO NUMBER	. LOCKWASHER		1
9	NO NUMBER	. NUT, .375-32 ---*---		1
10	201259-034	. CONNECTOR, Receptacle	A,B	2
11	200283-004	. TUBING, Heat Shrink	A,C	A/R
12	200357-272	. WIRE, Stranded, #18, CSA, Grn/Yel	A,C	A/R
13	200276-211	. TERMINAL, Lug Ring	A,C	1
14	200283-006	. TUBING, Heat Shrink	B,D	A/R
15	201301-612	. WIRE, Jumper, .650 L, AWG 22	A,B	3
	201301-612	. WIRE, Jumper, .650 L, AWG 22	C,D	1
16	201301-604	. WIRE, Jumper, .250 L, AWG 22		1

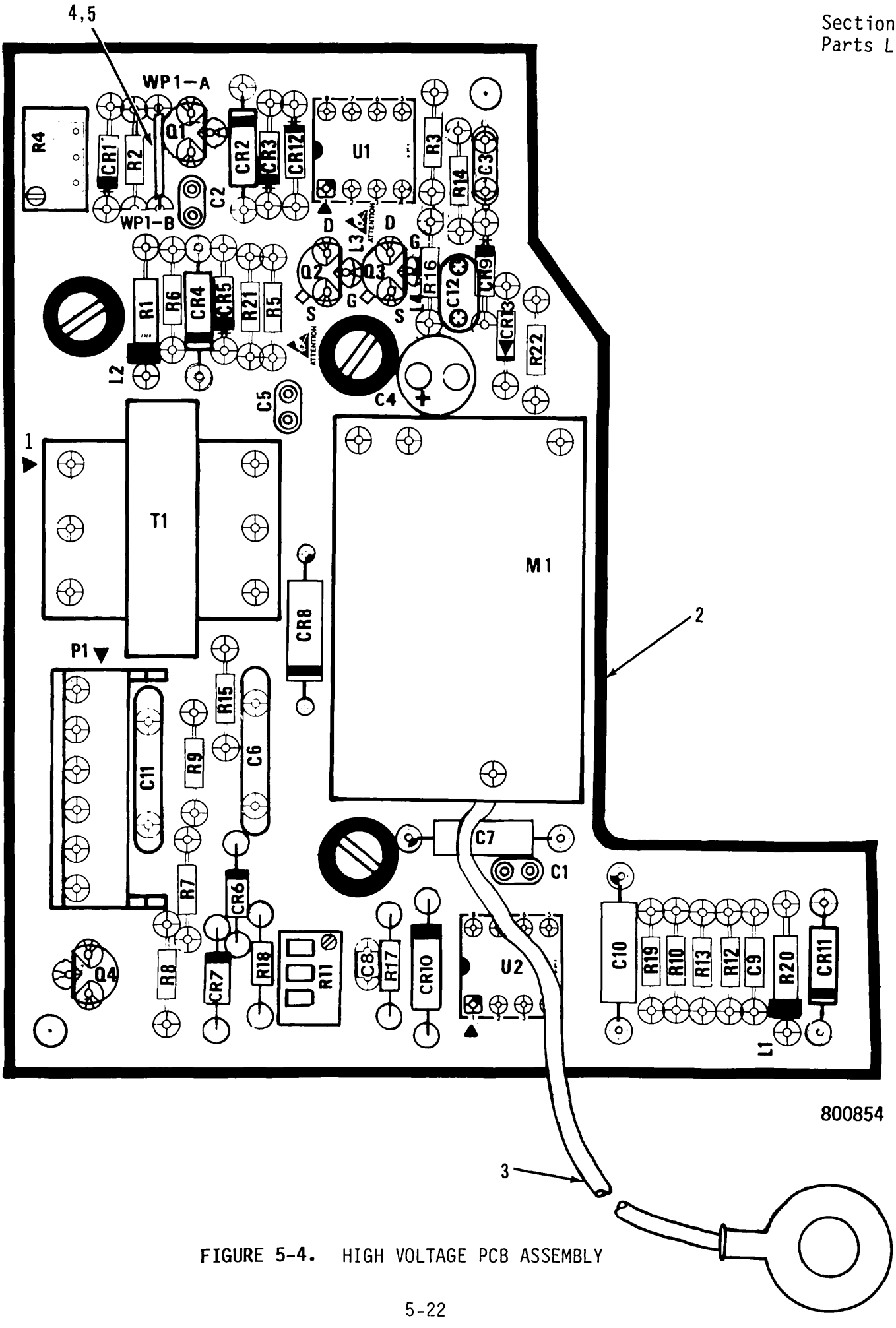


FIGURE 5-4. HIGH VOLTAGE PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-4				
1	800854-00	PCB ASSY, High Voltage		REF
2	800853-08	. BOARD, Printed Circuit		1
C1	200901-092	. CAPACITOR, 560pf/50V, 5%		1
C2	200901-095	. CAPACITOR, .001µf/100V, 5%		2
C3	200264-018	. CAPACITOR, .1µf/50V		1
C4	200205-049	. CAPACITOR, Electrolytic, 10µf/50V		1
C5		. (Same As C2)		
C6	200289-057	. CAPACITOR, .005µf/3KV		1
C7	200744-001	. CAPACITOR, .047µf/50V		1
C8	200893-051	. CAPACITOR, 100pf/100V		1
C9	200049-039	. CAPACITOR, .1µf/50V		1
C10	200744-005	. CAPACITOR, .1µf/50V		1
C11	200507-030	. CAPACITOR, .01µf/1KV		1
C12	200264-024	. CAPACITOR, 1.0µf/50V		1
CR1	200971-000	. DIODE, 1N914B		3
CR2	200083-000	. DIODE, 1N5817		1
CR3		. (Same As CR1)		
CR4	200658-002	. DIODE, MR812		1
CR5	200605-015	. DIODE, 1N4743A		1
CR6,7	800754-00	. DIODE, 1N992		1
CR8	200882-001	. DIODE, MX40		1
CR9		. (Same As CR1)		
CR10,11	200177-016	. DIODE, P6KE15/V		2
CR12	200605-016	. DIODE, 1N4744A		1
CR13	02-14155-00	. DIODE, UCD329		1
L1-4	02-18017-00	. INDUCTOR, Ferrite Bead		4
M1	800855-01	. MULTIPLIER, Hi Voltage		1
3	200188-000	CONNECTOR, Power Plug		1
Q1	200857-000	. TRANSISTOR, PN2369A		2
Q2,3	801338-01	. TRANSISTOR, VN0106N3 ATTENTION		2
Q4		. (Same As Q1)		
R1	200470-004	. RESISTOR, 1.5, 1/4W, 5%		1
R2	200470-096	. RESISTOR, 10 K, 1/4W, 5%		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-4				
R3	200470-108	. RESISTOR, 33 K, 1/4W, 5%		1
R4	200527-028	. RESISTOR, Pot, 10 K, 1/2W, 10%		1
R5	200470-072	. RESISTOR, 1 K, 1/4W, 5%		1
R6	200470-083	. RESISTOR, 3 K, 1/4W, 5%		1
R7,8	200468-168	. RESISTOR, 10 M, 1/4W, 5%		2
R9	200468-155	. RESISTOR, 3 M, 1/4W, 5%		2
R10	200470-144	. RESISTOR, 1 M, 1/4W, 5%		1
R11	200527-035	. RESISTOR, Pot, 500 K, 1/2W, 10%		1
R12,13	200055-317	. RESISTOR, 20 K, 1/8W, 1%		2
R14	200470-076	. RESISTOR, 1.5 K, 1/4W, 5%		1
R15		. (Same As R9)		
R16	200055-268	. RESISTOR, 6.19 K, 1/8W, 1%		1
R17	200470-048	. RESISTOR, 100, 1/4W, 5%		1
R18	200470-137	. RESISTOR, 510 K, 1/4W, 5%		1
R19	200470-117	. RESISTOR, 75 K, 1/4W, 5%		1
R20	200470-055	. RESISTOR, 200, 1/4W, 5%		1
R21	200054-297	. RESISTOR, 12.4 K, 1/8W, 1%		1
R22	200470-120	. RESISTOR, 100 K, 1/4W, 5%		1
T1	800879-00	. TRANSFORMER, Fly-back		1
U1	2-14359-00	. IC, NE555		1
U2	200487-000	. IC, LF353N		1
4	90-09138	. WIRE, Solid Buss, AWG 22		A/R
5	200624-004	. TUBING, Teflon, #22		A/R

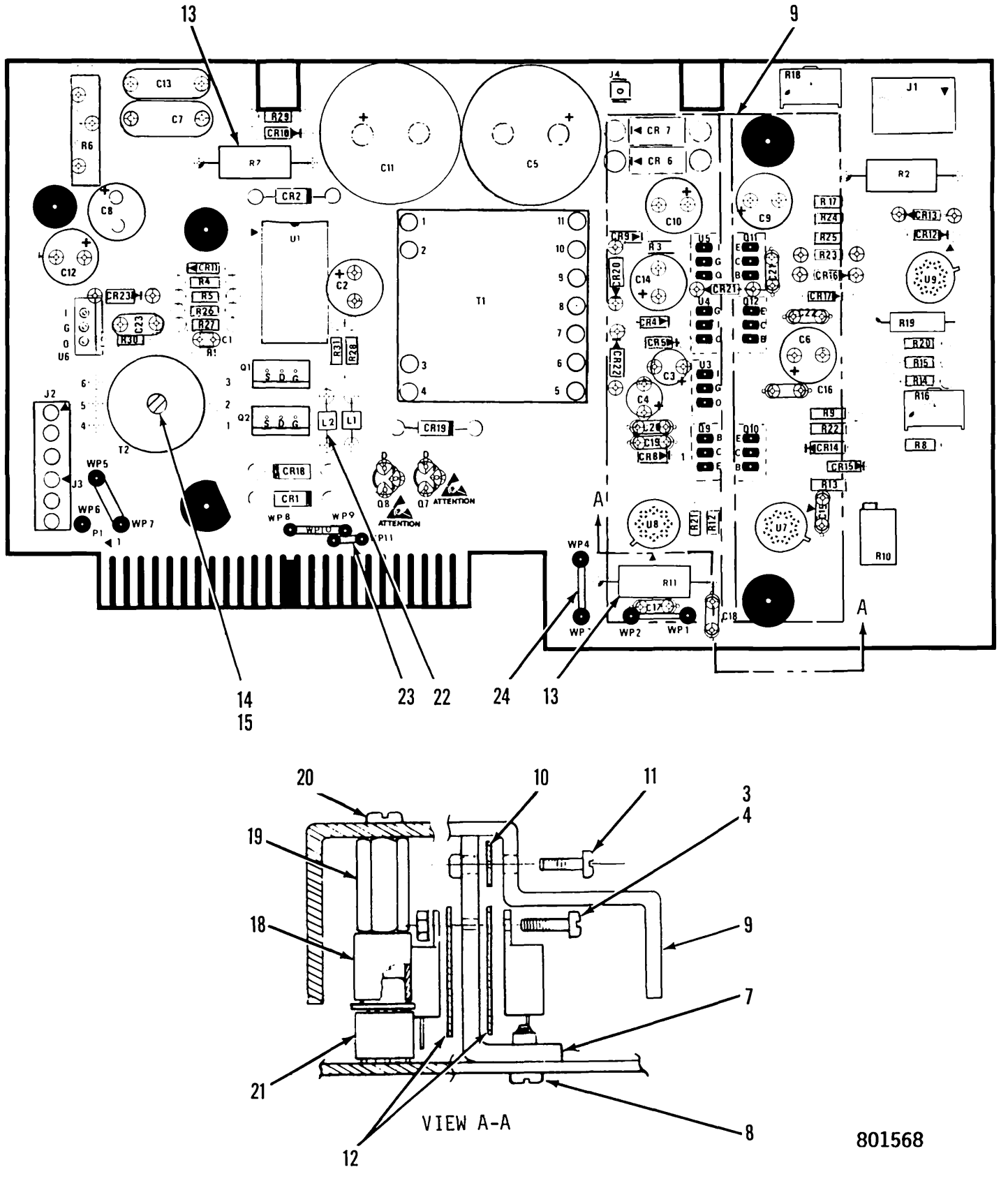


FIGURE 5-5. LOW VOLTAGE POWER SUPPLY/DEFLECTION AMP PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-5				
1	801568-01	PCB ASSY, Low Voltage Power Supply/ Deflection Amp		REF
2	801567-02	. BOARD, Printed Circuit		1
C1	200901-098	. CAPACITOR, 1800pF/100V		2
C2	200322-002	. CAPACITOR, Electrolytic, 68µF/25V		1
C3,4	200280-034	. CAPACITOR, Tantalum, 2.2µF/35V		2
C5	200322-009	. CAPACITOR, Electrolytic, 1000µF/25V		2
C6	200322-060	. CAPACITOR, Electrolytic, 22µF/50V		4
C7	200362-024	. CAPACITOR, .1µF/100V		1
C8	200205-074	. CAPACITOR, Electrolytic, 10µF/100V		1
C9,10		. (Same As C6)		
C11		. (Same As C5)		
C12	200322-079	. CAPACITOR, Electrolytic 4.7µF/100V		1
C14		. (Same As C6)		
C15,16	200507-019	. CAPACITOR, .001µF/1KV		2
C17-22	200264-018	. CAPACITOR, .1µF/50V		6
C23	200865-034	. CAPACITOR, 470pF/1KV		1
CR1,2	200177-043	. DIODE, P6KE51A		4
CR4,5	200658-002	. DIODE, MR812		8
CR6,7	201128-000	. DIODE, 3S1F1		2
CR8,9		. (Same As CR4)		
CR10	200658-007	. DIODE, MR818		1
CR11	200234-022	. DIODE, IN979B		1
CR14-17		. (Same As CR4)		
CR18,19		. (Same As CR1)		
CR20-23	200284-005	. DIODE, IN4005		4
J1	200096-002	. CONNECTOR, 4 Pin, Plug, Lock		1
J2	200523-000	. CONNECTOR, 2 Pin, Plug		1
J3	200523-001	. CONNECTOR, 3 Pin, Plug		1
J4	200396-ANY	. CONNECTOR, Plug, SIP		1

PARTS LIST

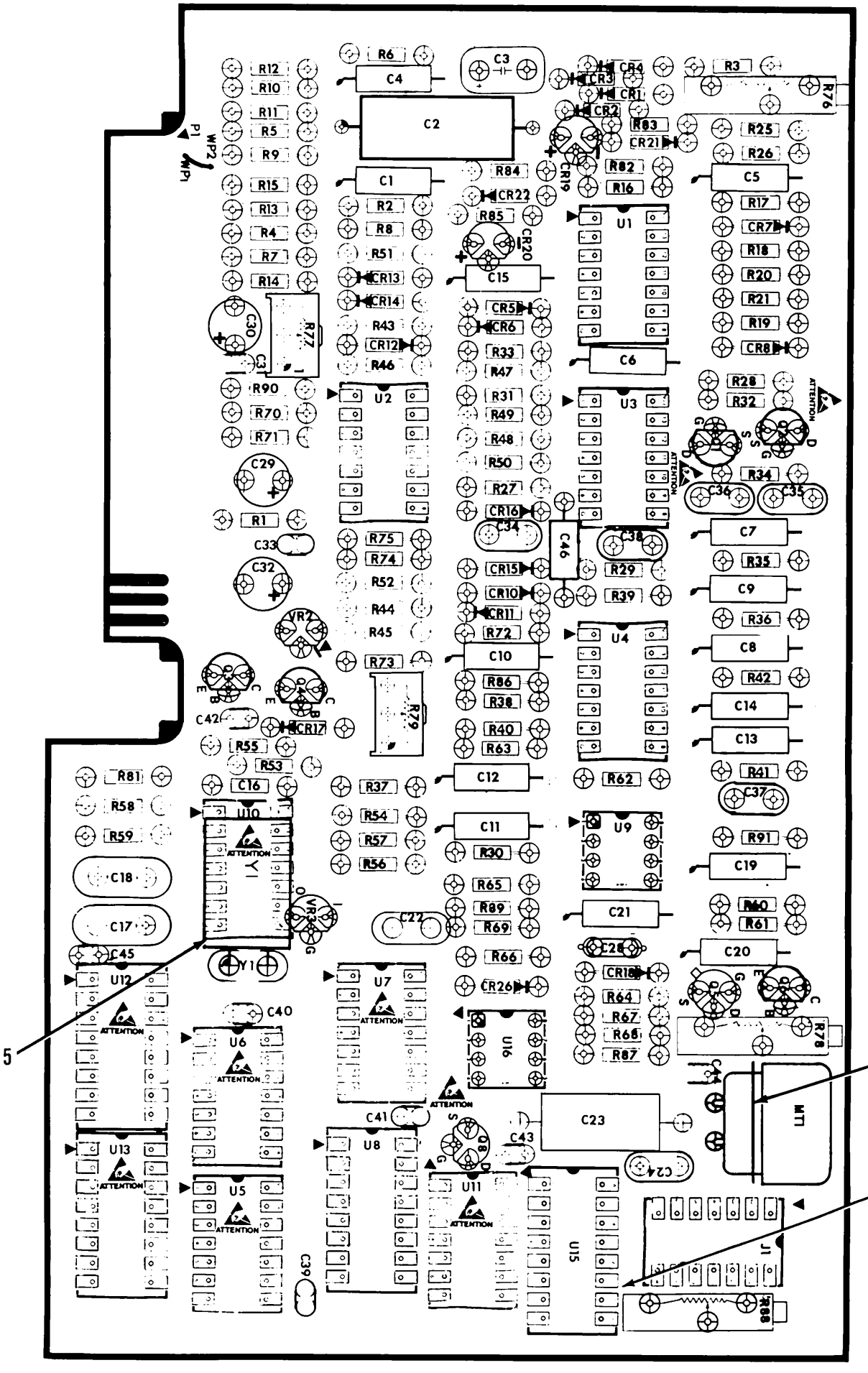
FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-5				
L1-4	200808-000	. INDUCTOR, Ferrite Bead		4
Q1,2	200953-003	. TRANSISTOR, IRF523		2
Q7,8	801338-01	. TRANSISTOR, VDS60V ATTENTION		2
Q9	2-14617-00	. TRANSISTOR D44H11		2
Q10	200621-000	. TRANSISTOR, D45H11 ---Attaching Parts		2
3	90-01235	. SCREW, 4-40 X .500L, Binder Head		1
4	90-03019	. NUT, Kep, 4-40 ---*---		1
Q11		. (Same As Q9)		
Q12		. (Same As Q10) ---Attaching Parts		
5	90-01235	. SCREW, 4-40X.500,Binder Head (Not Shown)		2
6	90-03019	. NUT, Kep, 4-40 (Not Shown) ---*---		2
7	800953-00	. HEATSINK ---Attaching Parts		1
8	200476-261	. SCREW, 4-40 X 5/16, Pan Head ---*---		2
9	800860-00	. HEATSINK, Cover		1
10	800878-00	. INSULATOR, Heatsink Cover ---Attaching Parts		1
11	200476-261	. SCREW, 4-40 X .312, Pan Head ---*---		3
12	800344-01	. INSULATOR, Heatsink		2
R1	200054-030	. RESISTOR, 20, 1/8W, 1%		1
R2	200270-024	. RESISTOR, 1, 2W, 5%		1
R3	200470-012	. RESISTOR, 3.3, 1/4W, 5%		1
R4	200470-106	. RESISTOR, 27 K, 1/4W, 5%		1
R5	200470-127	. RESISTOR, 200 K, 1/4W, 5%		1
R6	200505-017	. RESISTOR, POT, 1 M, 3/4W, 10%		1
R7		. (Same As R2)		
R8	200054-222	. RESISTOR, 2 K, 1/8W, 1%		1
R9	200054-204	. RESISTOR, 1.3 K, 1/8W, 1%		1
R10	200527-013	. RESISTOR, POT, 100 K, 1/2W, 10%		2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-5				
R11	200270-023	. RESISTOR, 91, 2W, 5%		1
R12	200470-072	. RESISTOR, 1 K, 1/4W, 5%		3
R13	200470-040	. RESISTOR, 47, 1/4W, 5%		1
R14	200470-079	. RESISTOR, 2 K, 1/4W, 5%		2
R15		. (Same As R12)		
R16	200503-009	. RESISTOR, POT, 10 K, 1/2W, 20%		1
R19	200124-016	. RESISTOR, 4.7, 1/2W, 5%		1
R20	200470-088	. RESISTOR, 4.7 K, 1/4W, 5%		1
R21	200470-024	. RESISTOR, 10, 1/4W, 5%		1
R22	200470-048	. RESISTOR, 100, 1/4W, 5%		1
R23		. (Same As R12)		
R24		. (Same As R10)		
R25	200470-058	. RESISTOR, 270, 1/4W, 5%		1
R26	200054-316	. RESISTOR, 19.6 K, 1/8W, 1%		1
R27	200054-134	. RESISTOR, 243, 1/8W, 1%		1
R28	200054-069	. RESISTOR, 51.1, 1/8W, 1%		2
R29	200470-096	. RESISTOR, 10 K, 1/4W, 5%		1
R30		. (Same As R14)		
R31		. (Same As R28)		
13	90-09089	. INSULATOR, Cradle Mount (Used on R7,R11)		2
T1	800416-04	. TRANSFORMER, Linear		1
T2	800963-00	. TRANSFORMER, Preamp Drive ---Attaching Parts		1
14	NONUMBER	. SCREW, Nylon 4-40 X 5/8		1
15	NONUMBER	. NUT, Nylon, 4-40 X 1/4 ---*---		1
U1	201126-000	. IC, SG3525AN		1
U3	200277-000	. IC, LM340T-5 ---Attaching Parts		1
16	90-01235	. SCREW, 4-40X.500, Binder Head (Not Shown)		1
17	90-03019	. NUT, Kep, 4-40, (Not Shown) ---*---		1
U4	200209-004	. IC, LM320T-12		1
U5,6	200227-003	. IC, LM340T-12		2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-5				
U7	200627-000	. IC, LF257H		2
U8	200622-000	. IC, LH0002CH		1
18	200522-000	. HEATSINK, Transistor		1
19	200266-014	. STANDOFF, 4-40 X .625 ---Attaching Parts		1
20	200475-260	. SCREW, 4-40 X .250, Binder Head ---*---		1
U9		. (Same As U7)		
21	201127-001	. SOCKET, IC (Used on U7, U8, U9)		3
22	90-09138	. WIRE, Solid Bus, AWG #22 (Used with L1,L2)		A/R
23	201301-603	. WIRE, Jumper, .200L, AWG #22		1
24	201301-607	. WIRE, Jumper, .400L, AWG #22		5



801445

FIGURE 5-6. SYSTOLE PROCESSOR PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-6				
A4	801445-04	PCB ASSY, Systole Processor		REF
2	801444-05	. BOARD, Printed Circuit		1
C1	200744-081	. CAPACITOR, .01µf/200V		3
C2	200744-021	. CAPACITOR, 2µf/50V		1
C3	200274-035	. CAPACITOR, 240pf/500V		1
C4		. (Same As C1)		
C5-8	200744-005	. CAPACITOR, .1µf/50V		12
C9	200744-001	. CAPACITOR, .047µf/50V		1
C10-13		. (Same As C5)		
C14		. (Same As C1)		
C15		. (Same As C5)		
C16	200049-000	. CAPACITOR, 56pf/50V		1
C17	200274-010	. CAPACITOR, 22pf/500V		1
C18	200274-018	. CAPACITOR, 47pf/500V		1
C19-21		. (Same As C5)		
C22	200893-046	. CAPACITOR, 1µf/50V		1
C23	200744-010	. CAPACITOR, .27µf/50V		1
C24	200264-018	. CAPACITOR, .1µf/50V		6
C28	200264-059	. CAPACITOR, 1µf/100V		1
C29-30	200280-063	. CAPACITOR, 22µf/35V		3
C31	200264-010	. CAPACITOR, .01µf/50V		9
C32		. (Same As C29)		
C33		. (Same As C31)		
C34-38		. (Same As C24)		
C39-45		. (Same As C31)		
C46	200049-039	. CAPACITOR, .1µf/50V		1
CR1-8, 10-18	200971-000	. DIODE, 1N914B		20
CR19, 20	200854-006	. IC, LM334Z		2
CR21, 22,26		. (Same As CR1)		
J1	200907-001	. SOCKET, IC		1
MT1	200115-000	. TRANSDUCER, Audio		1

PARTS LIST

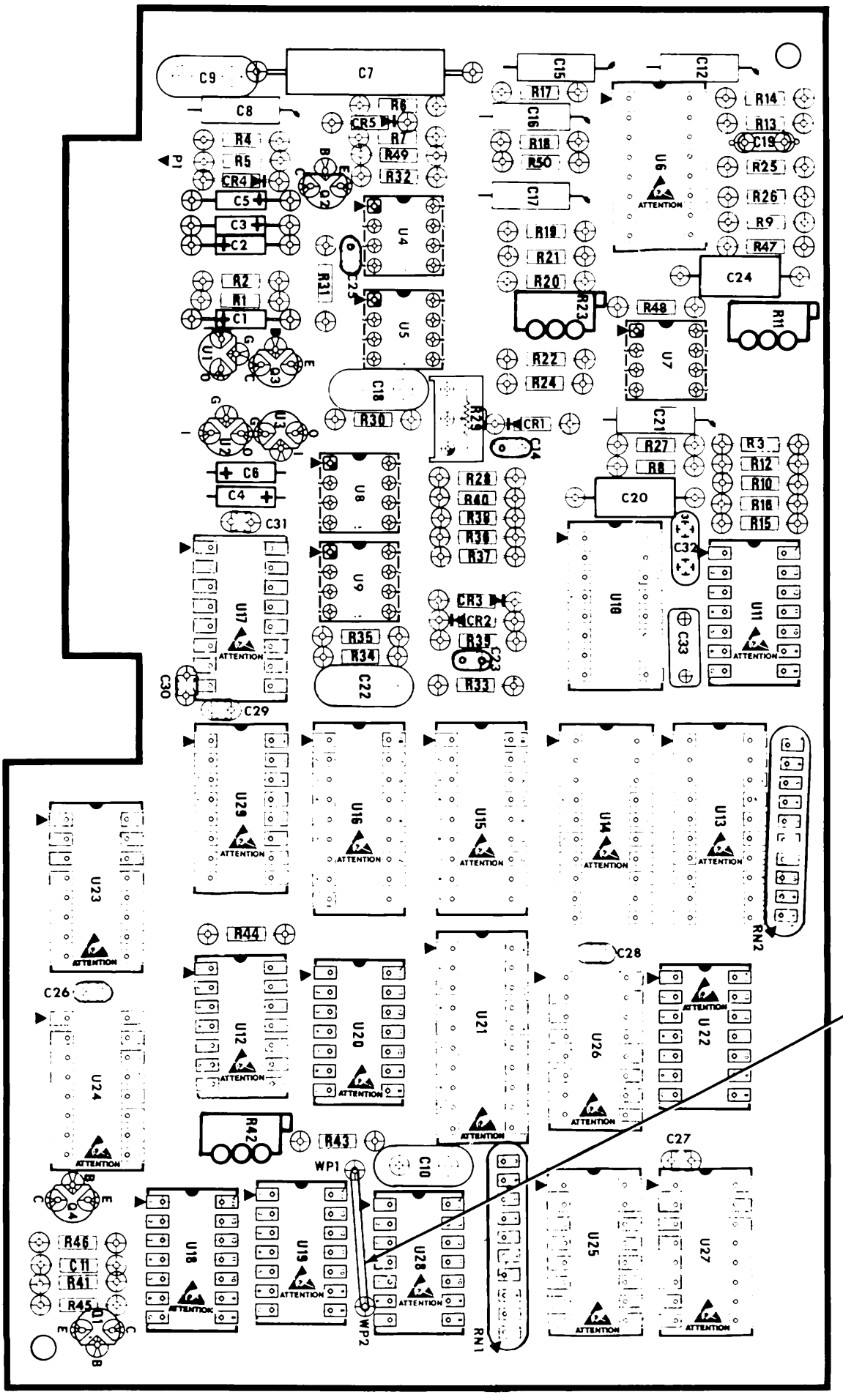
FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-6				
Q1,2	200585-001	. TRANSISTOR, VN0106N3 ATTENTION		3
Q3,4	200986-000	. TRANSISTOR, PN2484		3
Q5	200282-004	. TRANSISTOR, 2N4393		1
Q6		. (Same As Q3)		
Q8		. (Same As Q1)		
R1	200054-317	. RESISTOR, MF, 20 K, 1/8W, 1%, RN55C		4
R2	200470-160	. RESISTOR, CF, 4.7 M, 1/4W, 5%		1
R3	200054-279	. RESISTOR, MF, 8.06 K, 1/8W, 1%, RN55C		1
R4	200054-392	. RESISTOR, MF, 121 K, 1/8W, 1%, RN55C		1
R5	200470-072	. RESISTOR, CF, 1 K, 1/4W, 5%		4
R6	200054-288	. RESISTOR, MF, 10 K, 1/8W, 1%, RN55C		4
R7	200470-079	. RESISTOR, CF, 2 K, 1/4W, 5%		1
R8,9	200054-384	. RESISTOR, MF, 100 K, 1/8W, 1%, RN55C		5
R10	200054-386	. RESISTOR, MF, 105 K, 1/8W, 1%, RN55C		1
R11		. (Same As R8)		
R12	200054-259	. RESISTOR, MF, 4.99 K, 1/8W, 1%, RN55C		1
R13	200470-055	. RESISTOR, CF, 200, 1/4W, 5%		1
R14		. (Same As R6)		
R15	200054-330	. RESISTOR, MF, 27.4 K, 1/8W, 1%, RN55C		1
R16	200470-056	. RESISTOR, CF, 220, 1/4W, 5%		1
R17	200470-092	. RESISTOR, CF, 6.8 K, 1/4W, 5%		2
R18,19	200470-089	. RESISTOR, 5.1 K, 1/4W, 5%		5
R20		. (Same As R17)		
R21,25	200470-112	. RESISTOR, 47 K, 1/4W, 5%		2
R26	200470-134	. RESISTOR, 390 K, 1/4W, 5%		1
R27		. (Same As R8)		
R28	200470-096	. RESISTOR, 10 K, 1/4W, 5%		12
R29		. (Same As R8)		
R30,31		. (Same As R28)		
R32	200470-144	. RESISTOR, 1 M, 1/4W, 5%		3
R33	200054-321	. RESISTOR, MF, 22.1 K, 1/4W, 1%, RN55C		2
R34	200054-352	. RESISTOR, MF, 46.4 K, 1/8W, 1%, RN55C		1
R35	200054-343	. RESISTOR, MF, 37.4 K, 1/8W, 1%, RN55C		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-6				
R36		. (Same As R33)		
R37	200054-401	. RESISTOR, 150 K, 1/8W, 1%		2
R38,39	200054-425	. RESISTOR, 267 K, 1/8W, 1%		2
R40	200054-470	. RESISTOR, 787 K, 1/8W, 1%		1
R41		. (Same As R1)		
R42	200054-413	. RESISTOR, 200 K, 1/8W, 1%		1
R43,44		. (Same As R1)		
R45,46	200054-193	. RESISTOR, 1 K, 1/8W, 1%		4
R47		. (Same As R37)		
R48		. (Same As R28)		
R49	200470-120	. RESISTOR, 100 K, 1/4W, 5%		2
R50-52		. (Same As R28)		
R53		. (Same As R32)		
R54	200470-151	. RESISTOR, 2 M, 1/4W, 5%		1
R55	200470-139	. RESISTOR, 620 K, 1/4W, 5%		1
R56,57		. (Same As R28)		
R58		. (Same As R32)		
R59		. (Same As R28)		
R60	200054-575	. RESISTOR, MF, 10 M, 1/8W, 1%, RN55C		1
R61	200055-604	. RESISTOR, MF, 20 M, 1/8W, 1%, RN55D		1
R62	200470-048	. RESISTOR, CF, 100, 1/4W, 5%		1
R63	200470-141	. RESISTOR, CF, 750 K, 1/4W, 5%		1
R64		. (Same As R5)		
R65	200054-411	. RESISTOR, MF, 191 K, 1/8W, 1%, RN55C		1
R66	200470-163	. RESISTOR, CF, 6.2 M, 1/4W, 5%		1
R67		. (Same As R49)		
R68	200470-101	. RESISTOR, CF, 16 K, 1/4W, 5%		1
R69	200470-107	. RESISTOR, CF, 30 K, 1/4W, 5%		1
R70,71	200470-016	. RESISTOR, CF, 4.7, 1/4W, 5%		2
R72		. (Same As R18)		
R73	200470-111	. RESISTOR, 43 K, 1/4W, 5%		1
R74		. (Same As R5)		
R75	200470-081	. RESISTOR, 2.4 K, 1/4W, 5%		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-6				
R76	200505-008	. Pot, 5 K, 3/4W, 10%		1
R77	200503-006	. Pot, 1 K, 1/2W, 20%		1
R78	200505-010	. Pot, 20 K, 3/4W, 10%		1
R79	200503-012	. Pot, 50 K, 1/2W, 20%		1
R81		. (Same As R28)		
R82		. (Same As R45)		
R83		. (Same As R6)		
R84		. (Same As R45)		
R85		. (Same As R6)		
R86		. (Same As R5)		
R87		. (Same As R28)		
R88	200505-012	. RESISTOR, Pot, 50 K, 3/4W, 10%		1
R89		. (Same As R18)		
R90	200054-178	. RESISTOR, 698, 1/8W, 1%		1
R91		. (Same As R18)		
U1,2	200287-000	. IC, TL064		3
U3	200669-002	. IC, LM399N		1
U4		. (Same As U1)		
U5	200252-000	. IC, 4001B ATTENTION		1
U6,7	200182-000	. IC, 4013B ATTENTION		2
U8	200856-000	. IC, 7510D1JN		1
U9	200855-000	. IC, LF398N		1
U10	2-14437-00	. IC, 74C00 ATTENTION		1
U11	200181-000	. IC, 14069UBCP ATTENTION		1
U12,13	200714-000	. IC, 4040 ATTENTION		2
U15	201269-000	. IC, CA3162E		1
U16	200487-000	. IC, LF353N		1
3	200907-002	. SOCKET, IC		1
VR2	200445-000	. IC, LM329, Voltage Regulator		1
VR3	200636-000	. IC, LM340LAZ, Voltage Regulator		1
Y1	200874-000	. CRYSTAL, 660 KHz		1
4	90-09138	. WIRE, Solid Bus, AWG #22		A/R
5	200283-020	. TUBING, Heat Shrink		A/R



800159

FIGURE 5-7. NO-FADE PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-7				
A5	800159-04	PCB ASSY, No Fade		REF
2	800158-15	. BOARD, Printed Circuit		1
C1-6	200109-086	. CAPACITOR, Tant, 1µf/50V, 20%		6
C7	200744-021	. CAPACITOR, 2µf/50V, 5%		1
C8	200744-157	. CAPACITOR, .001µf/600V, 5%		2
C9	200274-038	. CAPACITOR, 330pf/500V, 5%		1
C10	200274-030	. CAPACITOR, 27pf/500V, 5%		1
C11	200049-039	. CAPACITOR, 1µf/50V, 20%		1
C12	200744-083	. CAPACITOR, .015µf/200V, 5%		1
C13	200901-022	. CAPACITOR, 100pf/50V, 5%		1
C15		. (Same As C8)		
C16,17	200744-120	. CAPACITOR, 2200pf/400V, 5%		2
C18	200274-024	. CAPACITOR, 82pf/500V, 5%		1
C19	200264-059	. CAPACITOR, 1µf/100V, 20%		1
C20	200744-005	. CAPACITOR, .1µf/50V, 5%		2
C21	200744-081	. CAPACITOR, .01µf/100V, 5%		1
C22	200274-042	. CAPACITOR, 470pf/500V, 5%		1
C23	200893-002	. CAPACITOR, 220pf/50V, 10%		1
C24		. (Same As C20)		
C25	200902-027	. CAPACITOR, 270pf/50V, 5%		1
C26-31	200264-010	. CAPACITOR, .01µf/50V, 20%		6
C32	200901-053	. CAPACITOR, .039µf/50V, 5%		1
C33	200966-003	. CAPACITOR, .1µf/100V, 5%		1
CR1-5	200971-000	. DIODE, 1N914B		5
R1,2	200470-024	. RESISTOR, 10, 1/4W, 5%		2
R3	200054-320	. RESISTOR, 21.5 K, 1/8W, 1%, RN55C		1
R4	200054-430	. RESISTOR, 301 K, 1/8W, 1%, RN55C		1
R5	200054-434	. RESISTOR, 332 K, 1/8W, 1%, RN55C		1
R6	200470-144	. RESISTOR, 1 M, 1/4W, 5%		1
R7	200470-160	. RESISTOR, 4.7 M, 1/4W, 5%		1
R8	200470-096	. RESISTOR, CF, 10 K, 1/4W, 5%		5
R9	200054-339	. RESISTOR, MF, 34 K, 1/8W, 1%, RN55C		1
R10	200054-288	. RESISTOR, MF, 10 K, 1/8W, 1%, RN55C		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-7				
R11	200527-006	. POT, 1 K, 1/2W, 10%		2
R12	200054-262	. RESISTOR, MF, 5.36 K, 1/8W, 1%, RN55C		1
R13	200054-378	. RESISTOR, MF, 86.6 K, 1/8W, 1%, RN55C		1
R14	200054-424	. RESISTOR, MF, 261 K, 1/8W, 1%, RN55C		1
R15	200054-222	. RESISTOR, MF, 2 K, 1/8W, 1%, RN55C		2
R16	200470-080	. RESISTOR, CF, 2.2 K, 1/4W, 5%		1
R17	200054-193	. RESISTOR, MF, 1 K, 1/8W, 1%, RN55C		5
R18	200054-238	. RESISTOR, MF, 2.94 K, 1/8W, 1%, RN55C		1
R19	200054-225	. RESISTOR, MF, 2.15 K, 1/8W, 1%, RN55C		1
R20	200054-199	. RESISTOR, MF, 1.15 K, 1/8W, 1%, RN55C		1
R21	200054-302	. RESISTOR, MF, 14 K, 1/8W, 1%, RN55C		1
R22	200470-091	. RESISTOR, CF, 6.2 K, 1/4W, 5%		1
R23		. (Same As R11)		
R24	200470-072	. RESISTOR, CF, 1 K, 1/4W, 5%		1
R25	200054-522	. RESISTOR, MF, 2.8 M, 1/8W, 1%, RN55C		1
R26	200054-276	. RESISTOR, MF, 7.5 K, 1/8W, 1%, RN55C		1
R27	200054-370	. RESISTOR, MF, 71.5 K, 1/8W, 1%, RN55C		1
R28		. (Same As R8)		
R29	200503-013	. POT, 100 K, 1/2W, 20%		1
R30	200470-079	. RESISTOR, 2 K, 1/4W, 5%		1
R31		. (Same As R8)		
R32	200470-089	. RESISTOR, 5.1 K, 1/4W, 5%		3
R33	200470-082	. RESISTOR, 2.7 K, 1/4W, 5%		1
R34	200470-101	. RESISTOR, 16 K, 1/4W, 5%		1
R35-37		. (Same As R17)		
R38	200054-165	. RESISTOR, 511, 1/8W, 1%		1
R39		. (Same As R17)		
R40		. (Same As R15)		
R42	200527-010	. POT, 20 K, 1/2W, 10%		1
R43	200054-244	. RESISTOR, 3.4 K, 1/8W, 1%		1
R44,45		. (Same As R8)		
R46		. (Same As R32)		

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-7				
R47	200054-499	. RESISTOR, MF, 1.62 M, 1/8W, 1%, RN55C		1
R48	200054-413	. RESISTOR, MF, 200 K, 1/8W, 1%, RN55C		1
R49	200470-112	. RESISTOR, CF, 47 K, 1/4W, 5%		1
R50		. (Same As R32)		
RN1,2	2-11186-01	. RESNET, 10 X 25/50 K, 1%		2
Q1	801233-01	. TRANSISTOR, PN2907A		2
Q2	801507-00	. TRANSISTOR, 2N3903		1
Q3		. (Same As Q1)		
Q4	200791-000	. TRANSISTOR, 2N3903		1
U1,2	200636-000	. IC, LM340LAZ		2
U3	200209-016	. IC, LM320LZ		1
U4	200327-003	. IC, CA3130E		1
U5	200487-000	. IC, LF353N		4
U6	800741-00	. IC, CD4053 ATTENTION		1
U7-9		. (Same As U5)		1
U10	200630-001	. IC, DAC0808		1
U11	200182-000	. IC, 4013B ATTENTION		4
U12	200221-000	. IC, 4071B ATTENTION		1
U13,14	200711-000	. IC, 74C37 ATTENTION		3
U15,16	200529-001	. IC, Memory, 1024 X 4 ATTENTION		2
U17	200290-000	. IC, 74C163 ATTENTION		6
U18		. (Same As U11)		
U19	2-14426-00	. IC, 74C14 ATTENTION		1
U20		. (Same As U11)		
U21		. (Same As U13)		
U22		. (Same As U11)		
U23-27		. (Same As U17)		
U28	200183-000	. IC, 4081B ATTENTION		1
U29	200710-000	. IC, RAM, 1024 X 1 ATTENTION		1
3	90-09138	. WIRE, Solid Bus, AWG #22		A/R
4	200624-004	. TUBING, Teflon, Thin Wall		A/R

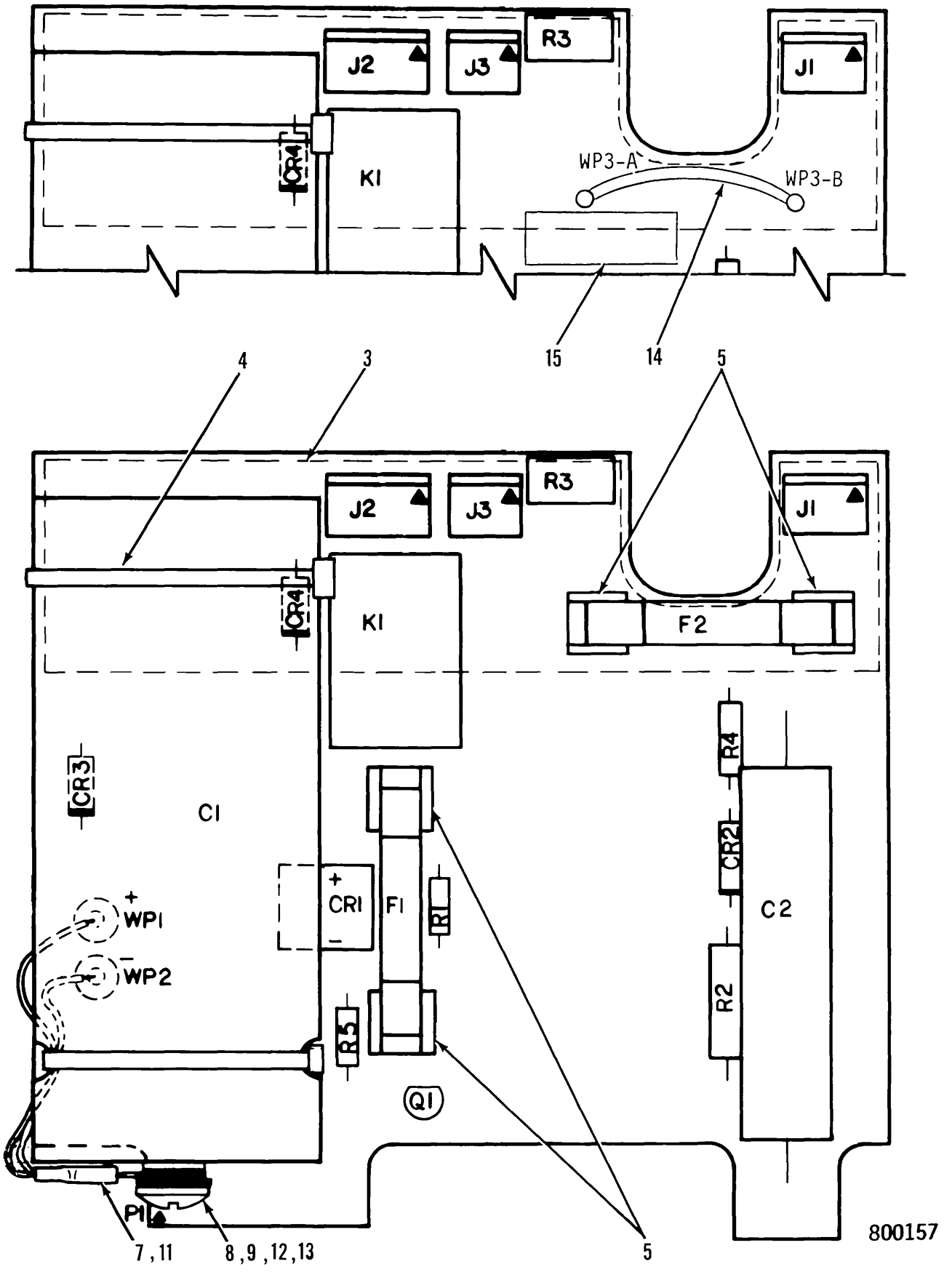


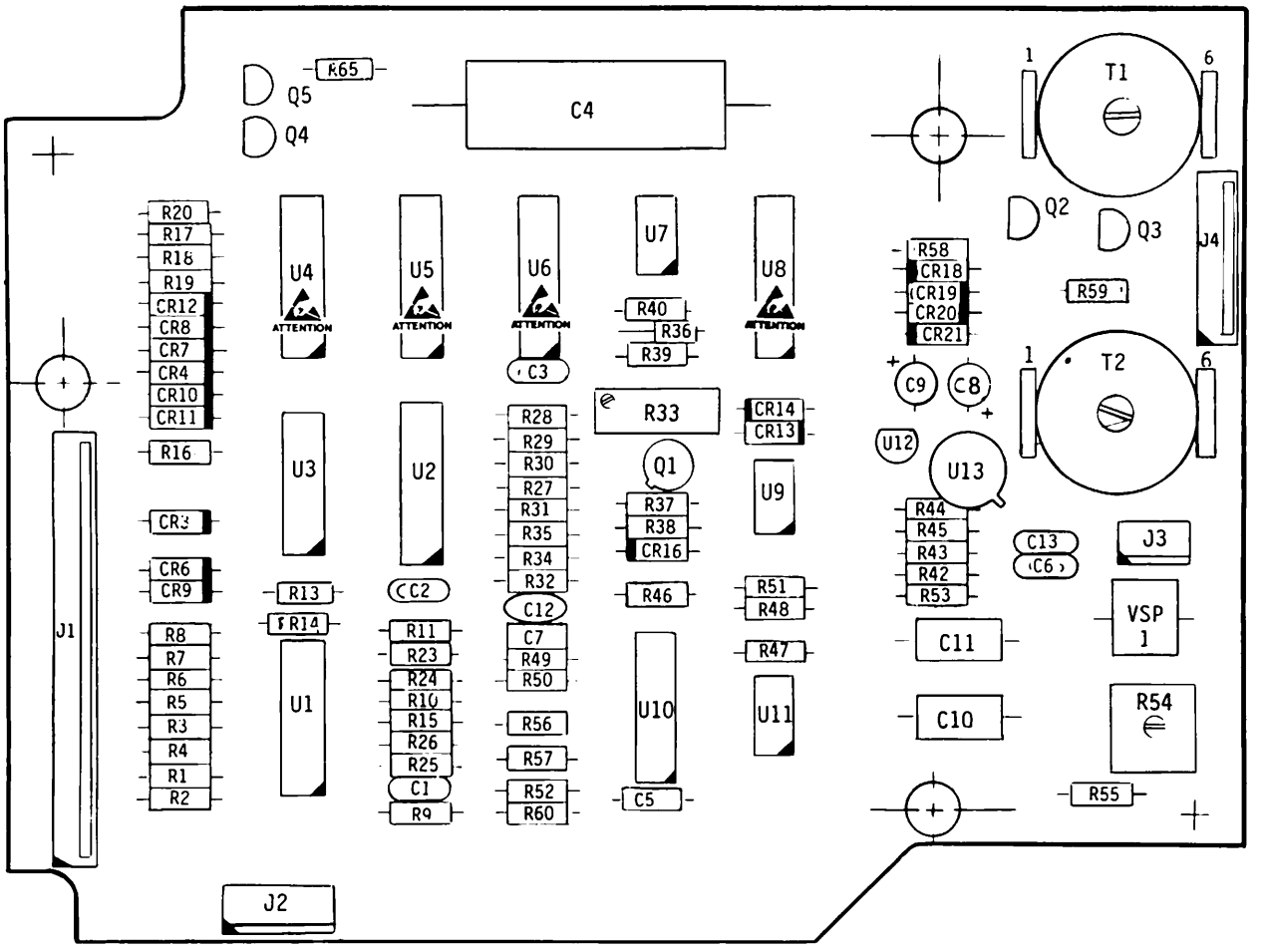
FIGURE 5-8. CHARGER PCB ASSEMBLY, MONITOR

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-8				
A6	800157-07	PCB ASSY, Charger	A	REF
	800157-08	PCB ASSY, Charger	B	
	800157-09	PCB ASSY, Charger	C	
2	800156-04	. BOARD, Printed Circuit		1
C1	200100-001	. CAPACITOR, Electrolytic, 9000µf/25V		1
3	801420-00	. SHIELD, Nomex ---Attaching Parts		1
4	90-10012	. RETAINER, Cable Tie ---*---		2
C2	200545-072	. CAPACITOR, Electrolytic, 120µf/30V	A,C	1
CR1	2-14173-00	. DIODE, VM48	A,C	1
CR2	200086-021	. DIODE, IN4106	A,C	1
CR3,4	200798-005	. DIODE, 3056		2
F1	200256-149	. FUSE, Slow, 3A/250V		1
F2	200256-134	. FUSE, Slow, .5A/250V	A,B	1
5	2-35464-00	. RETAINER, Fuse	A,B	4
	2-35464-00	. RETAINER, Fuse	C	2
J1	200972-000	. CONNECTOR, Plug		1
J2	200096-001	. CONNECTOR, Plug		1
J3	200096-000	. CONNECTOR, Plug		1
K1	2-18569-01	. RELAY - Coil		1
Q1	200889-000	. TRANSISTOR, PN2907A	A,C	1
R1	200470-048	. RESISTOR, 100, 1/4W, 5%	A,C	1
R2	200124-020	. RESISTOR, 6.8, 1/2W, 5%	A,C	1
R3	200503-000	. POT, 5 K, 1/2W, 20%	A,C	1
R4	200470-072	. RESISTOR, 1 K, 1/4W, 5%	A,C	1
R5	200470-064	. RESISTOR, 470, 1/4W, 5%	A,C	1
6	200357-109	. WIRE, Stranded, #22, CSA, Black		A/R
7	90-06043	. TERMINAL, Lug, #10 ---Attaching Parts		1
8	200475-355	. SCREW, 10-32 X .250, Binder Head		1
9	90-04018	. LOCKWASHER, #10 ---*---		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-8				
10	200357-110	. WIRE, Stranded #22, CSA, Red		A/R
11	90-06043	. TERMINAL, Lug, #10 ---Attaching Parts		1
12	200475-355	. SCREW, 10-32 X .250, Binder Head		1
13	90-04018	. WASHER, Lock, #10 ---*---		1
14	200358-059	. WIRE, Stranded, #18, CSA, Blue	C	A/R
15	90-09304	. LABEL, Plain	C	1



800101

FIGURE 5-9A. PREAMP PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-9A				
A7	800101-03	PCB ASSY, Preamp	A	REF
	800101-04	PCB ASSY, Preamp	B	
2	800100-05	. BOARD, Printed Circuit		1
C1	200264-024	. CAPACITOR, 1.0µf/50V, 20%		1
C2	200893-051	. CAPACITOR, 100pf/100V, 10%		2
C3	200901-223	. CAPACITOR, 4700pf/100V, 20%		1
C4	200744-030	. CAPACITOR, 10µf/50V, 5%		1
C5	200049-038	. CAPACITOR, .082µf/50V, 20%		1
C6	200264-026	. CAPACITOR, 2.2µf/50V, 20%		2
C7	200049-039	. CAPACITOR, .1µf/50V, 20%		1
C8,9	200500-048	. CAPACITOR, Tantalum, 4.7µf/20V, 20%		2
C10	200744-081	. CAPACITOR, .01µf/200V, 5%		1
C11	200744-005	. CAPACITOR, 1µf/50V, 5%		1
C12		. (Same As C2)		
C13		. (Same As C6)		
CR3,4, 6-14, 16,8-21	200961-000	. DIODE, 1N914B		16
J1	200073-012	. CONNECTOR, Plug, Flex, 18 Pin		1
J2	200096-001	. CONNECTOR, Plug, Lock, 3 Pin		1
J3	200095-000	. CONNECTOR, Plug, Lock, 2 Pin		1
J4	200073-000	. CONNECTOR, Plug, Flex, 6 Pin		1
Q1	200282-004	. TRANSISTOR, JFET, 2N4393		1
Q2,3	200429-000	. TRANSISTOR, JFET (Same Mfg), 2N5116		2
Q4,5	200883-000	. TRANSISTOR, PNP, 2N3905		2
R1	200054-575	. RESISTOR, 10 M, 1/8W, 1%		4
R2	200054-355	. RESISTOR, 49.9 K, 1/8W, 1%		8
R3		. (Same As R1)		
R4		. (Same As R2)		
R5		. (Same As R1)		
R6		. (Same As R2)		
R7		. (Same As R1)		

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-9A				
R8		. (Same As R2)		
R9	200470-148	. RESISTOR, 1.5 M, 1/4W, 5%		1
R10	200470-132	. RESISTOR, 330 K, 1/4W, 5%		1
R11	200470-137	. RESISTOR, 510 K, 1/4W, 5%		1
R13-15	200470-106	. RESISTOR, 27 K, 1/4W, 5%		3
R16-20	200470-096	. RESISTOR, 10 K, 1/4W, 5%		6
R23	200470-151	. RESISTOR, 2 M, 1/4W, 5%		2
R24	200054-427	. RESISTOR, 280 K, 1/8W, 1%, RN55C		2
R25		. (Same As R23)		
R26		. (Same As R24)		
R27	200054-317	. RESISTOR, 20 K, 1/8W, 1%		2
R28		. (Same As R2)		
R29	200054-292	. RESISTOR, 11 K, 1/8W, 1%		2
R30		. (Same As R2)		
R31		. (Same As R27)		
R32	200054-288	. RESISTOR, 10 K, 1/8W, 1%		7
R33	200527-026	. POT, 2 K, 1/2W, 10%		1
R34		. (Same As R29)		
R35	200054-480	. RESISTOR, MF, 1 M, 1/8W, 1%, RN55C		1
R36	200323-000	. RESISTOR, CC, 30 M, 3/4W, 5%		1
R37	200470-084	. RESISTOR, CF, 3.3 K, 1/4W, 5%		1
R38	200468-176	. RESISTOR, CC, 22 M, 1/8W, 1%, RN55C		1
R40	200470-072	. RESISTOR, CF, 1 K, 1/4W, 5%		2
R42		. (Same As R32)		
R43	200054-272	. RESISTOR, 6.81 K, 1/8W, 1%		2
R44		. (Same As R32)		
R45		. (Same As R43)		
R46	200470-144	. RESISTOR, 1 M, 1/4W, 5%		1
R47		. (Same As R2)		
R48-50		. (Same As R32)		
R51,52	200054-329	. RESISTOR, 26.7 K, 1/8W, 1%, RN55C	A	2
R51,52	200054-343	. RESISTOR, 37.4 K, 1/8W, 1%, RN55C	B	2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-9A				
R53	200054-425	. RESISTOR, 267 K, 1/8W, 1%		1
R54	200504-012	. POT, 50 K, 1/2W 20%		1
R55	200054-421	. RESISTOR, 243 K, 1/8W, 1%		1
R56		. (Same As R32)		
R57		. (Same As R2)		
R58	200470-133	. RESISTOR, 360 K, 1/4W, 5%		1
R59	200470-141	. RESISTOR, 750 K, 1/4W, 5%		1
R60		. (Same As R40)		
R65		. (Same As R16)		
T1,2	2-18284-00	. TRANSFORMER, Preamp		2
U1,2	201214-002	. IC, LF444		3
U3	2-11196-00	. RESNET, Wilson Network		1
U4,5	200044-000	. IC, CD4051B (Same Mfg) ATTENTION		2
U6	800741-00	. IC, CD4053 ATTENTION		2
U7	200254-003	. IC, LF255N		1
U8		. (Same As U6)		
U9	200254-000	. IC, LF355N		2
U10		. (Same As U1)		
U11		. (Same As U9)		
U12	200673-003	. IC, 78L08		1
U13	200706-014	. IC, 79M08		1
VSP1	200324-013	. VOLTAGE SURGE PROTECTOR, 920V		1

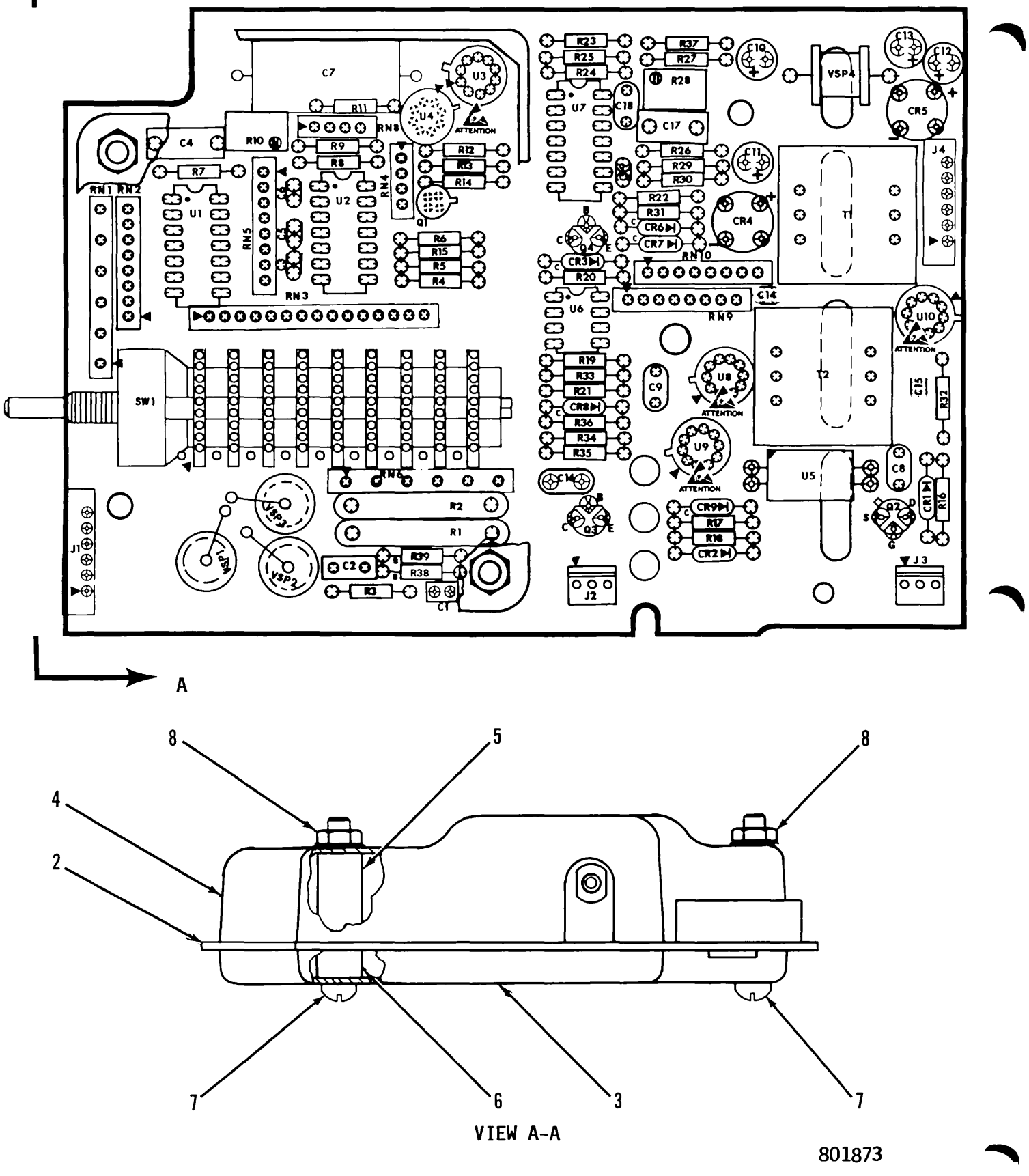


FIGURE 5-9B. PREAMP PCB ASSY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-9B				
A7	801873-00	PCB ASSY, Preamp		REF
2	801872-03	. BOARD, Printed Circuit		1
3	802199-00	. SHIELD, Preamp Bottom		1
4	802198-00	. SHIELD, Preamp Top		1
5	201124-398	. SPACER, .625 X .250 OD		2
6	201124-391	. SPACER, .187 X .250 OD ---Attaching Parts		2
7	200475-772	. SCREW, 4-40 X 1.000, Pan Head		2
8	90-03019	. NUT, Kep, 4-40 ---*---		2
C1	200893-271	. CAPACITOR, 4.7µf/100V		1
C2	200893-046	. CAPACITOR, 1µf/50V		2
C3	200893-051	. CAPACITOR, 100pf/100V		4
C4	200264-026	. CAPACITOR, 2.2µf/50V		1
C5,6		. (Same As C3)		
C7	200744-023	. CAPACITOR, 3µf/50V		1
C8,9	200893-234	. CAPACITOR, .1µf/50V		2
C10-13	200500-038	. CAPACITOR, Tantalum, 10µf/25V		4
C14,15	200893-210	. CAPACITOR, 1µf/50V		2
C16		. (Same As C2)		
C17	201290-024	. CAPACITOR, .1µf/50V		1
C18	200901-046	. CAPACITOR, .01µf/50V		1
C19		. (Same As C3)		
CR1-3	200971-000	. DIODE, 1N914B		7
CR4,5	200510-001	. DIODE, Rectifier, 2000ns, 1A, 50V		2
CR6-9		. (Same As CR1)		
J1	200073-000	. CONNECTOR, Plug		2
J2,3	200534-001	. CONNECTOR, Plug		2
J4		. (Same As J1)		
Q1	200582-004	. TRANSISTOR, VCR7N		1
Q2	200585-001	. TRANSISTOR, VN0106N3		1
Q3,4	200888-001	. TRANSISTOR, PN2907A		2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-9B				
R1,2	801967-01	. RESISTOR, 500 K, (Matched Pair)		2
R3	200470-151	. RESISTOR, 2 M, 1/4W, 5%		1
R4	200470-132	. RESISTOR, 330 K, 1/4W, 5%		1
R5	200470-137	. RESISTOR, 510 K, 1/4W, 5%		1
R6	200054-252	. RESISTOR, 4.22 K, 1/8W, 1%		1
R7	200054-284	. RESISTOR, 9.09 K, 1/8W, 1%		3
R8	200054-480	. RESISTOR, 1 M, 1/8W, 1%		1
R9	200054-281	. RESISTOR, 8.45 K, 1/4W, 1%		1
R10	200527-025	. POT, 1 K, 1/2W, 10%		1
R11	200054-592	. RESISTOR, 15 M, 1/8W, 1%		1
R12	200054-380	. RESISTOR, 90.9 K, 1/8W, 1%		1
R13	200554-424	. RESISTOR, 261 K, 1/8W, 1%		1
R14	200470-107	. RESISTOR, 30 K, 1/4W, 5%		1
R15	200470-165	. RESISTOR, 7.5 M, 1/4W, 5%		1
R16	200470-127	. RESISTOR, 200 K, 1/4W, 5%		1
R17,18	200470-096	. RESISTOR, 10 K, 1/4W, 5%		3
R19,20	200470-109	. RESISTOR, 36 K, 1/4W, 5%		2
R21	200054-413	. RESISTOR, 200 K, 1/8W, 1%		1
R22	200054-376	. RESISTOR, 82.5 K, 1/8W, 1%		1
R23,24		. (Same As R7)		
R25,26	200054-329	. RESISTOR, 26.7 K, 1/8W, 1%		2
R27	200054-421	. RESISTOR, 243 K, 1/8W, 1%		1
R28	200527-031	. POT, 50 K, 1/2W, 10%		1
R29	200054-428	. RESISTOR, 287 K, 1/8W, 1%		1
R30,31	200470-061	. RESISTOR, 360, 1/4W, 5%		2
R32	200470-120	. RESISTOR, 100 K, 1/4W, 5%		1
R33	200470-144	. RESISTOR, 1 M, 1/4W, 5%		1
R34	200054-313	. RESISTOR, 18.2 K, 1/8W, 1%		1
R35		. (Same As R17)		
R36	200054-320	. RESISTOR, 21.5 K, 1/8W, 1%		1
R37	200054-367	. RESISTOR, 66.7 K, 1/8W, 1%		1
R38,39	200054-068	. RESISTOR, 49.9 K, 1/8W, 1%		2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-9B				
RN1	801966-00	. RESNET, 4 X 10 M		2
RN2	201425-021	. RESNET, 4 X 50 K		1
RN3	801962-00	. RESNET, 2 K Wilson		1
RN4	201425-004	. RESNET, 2 X 20 K		1
RN5	201425-018	. RESNET, 4 X 20 K		1
RN6		. (Same As RN1)		
RN8	201425-040	. RESNET, 10 K - 90 K		1
RN9,10	201240-018	. RESNET, 4 X 100 K		2
SW1	802011-00	. SWITCH, Rotary		1
T1,2	802012-00	. TRANSFORMER, Isolation		2
U1	201214-002	. IC, LF444A		2
U2	801147-00	. IC, TL084		1
U3	201342-022	. IC, ANLG. 304 ATTENTION		1
U4	200254-008	. IC, FL255H		1
U5	200876-000	. ISOLATOR, Optic-opto, CLA-7		1
U6	200345-001	. IC, LM393A		1
U7		. (Same As U1)		
U8	201342-002	. IC, ANLG, 305 ATTENTION		1
U9,10	201342-012	. IC, ANLG, 301 ATTENTION		2
VSP1-3	200324-011	. VSP-470 VAC, B2-B470		3
VSP4	802196-00	. VSP-7.9 KVAC, B2-H80		1

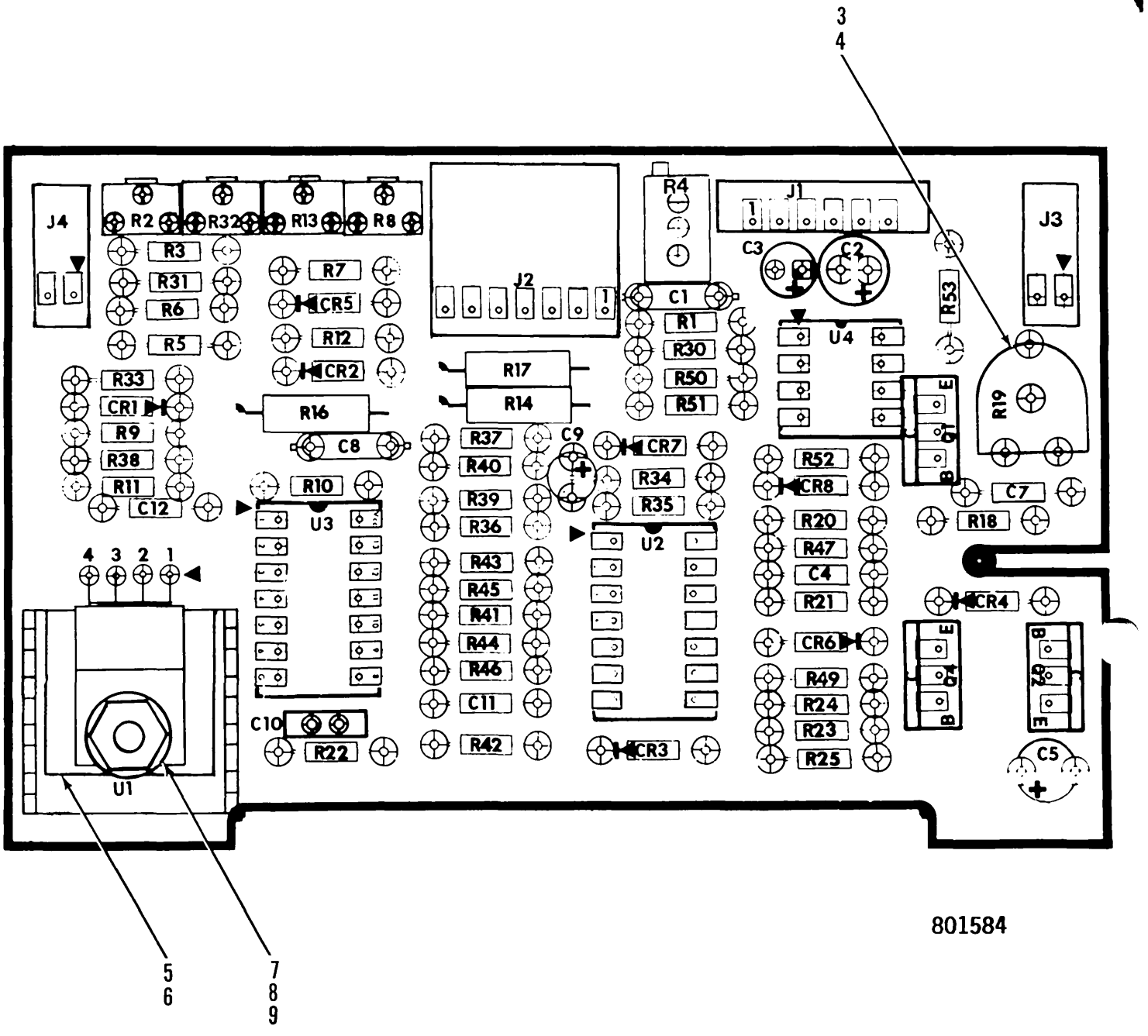


FIGURE 5-10. RECORDER PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-10				
A8	801584-00	PCB ASSY, Recorder		REF
2	801583-01	. BOARD, Printed Circuit		1
C1	200966-017	. CAPACITOR, .033µf/250V, 5%		1
C2	200205-016	. CAPACITOR, Electrolytic, 33µf/16V, +50%		1
C3	200205-034	. CAPACITOR, Electrolytic, 4.7µf/35V, +50%		1
C4	200049-003	. CAPACITOR, 100pf/50V, 20%		1
C5	200280-053	. CAPACITOR, Tantalum, 10µf/35V, 10%		1
C7	200049-039	. CAPACITOR, .1µf/50V, 20%		1
C8	200966-018	. CAPACITOR, .047µf/250V, 5%		1
C9	200356-022	. CAPACITOR, Tantalum, 1µf/35V, 20%		1
C10	200264-020	. CAPACITOR, .22µf/50V, 20%		1
C11	200049-021	. CAPACITOR, .0033µf/50V, 20%		1
C12	200049-027	. CAPACITOR, .01µf/50V, 20%		1
CR1,2	200096-011	. DIODE, 1N4625		3
CR3,4	200658-000	. DIODE, MR810		2
CR5		. (Same As CR1)		
CR6		. (Same As CR3)		
CR7,9	200961-000	. DIODE, 1N914B		2
J1	200073-000	. CONNECTOR, Plug, Flex, 6 Pin		1
J2	200892-005	. CONNECTOR, Plug, 90°, 7 Pin		1
J3,4	200892-000	. CONNECTOR, Plug, 90°, 2 Pin		2
Q1	200617-001	. TRANSISTOR, D45D2		2
Q2	200616-001	. TRANSISTOR, D44D2		1
Q4		. (Same As Q1)		
R1	200054-334	. RESISTOR, 30.1 K, 1/8W, 1%		1
R2	201142-007	. POT, 2 K, 3/4W, 20%		2
R3	200470-096	. RESISTOR, 10 K, 1/4W, 5%		6
R4	200527-009	. POT, 10 K, 1/2W, 10%		1
R5	200054-288	. RESISTOR, 10 K, 1/8W, 1%		1
R6		. (Same As R3)		
R7	200470-076	. RESISTOR, 1.5 K, 1/4W, 5%		2

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-10				
R8	201142-009	. POT, 10 K, 3/4W, 20%		1
R9	200470-144	. RESISTOR, 1 M, 1/4W, 5%		2
R10		. (Same As R7)		
R11	200470-089	. RESISTOR, 5.1 K, 1/4W, 5%		2
R12	200470-048	. RESISTOR, 100, 1/4W, 5%		1
R13	200142-012	. POT, 100 K, 3/4W, 20%		1
R14	200471-000	. RESISTOR, 1, 1/2W, 5%		2
R16	200124-060	. RESISTOR, 330, 1/2W, 5%		1
R17		. (Same As R14)		
R18	200470-118	. RESISTOR, 82 K, 1/4W, 5%		3
R19	200285-029	. POT, 100 K, .15W, 30%		1
R20	200470-104	. RESISTOR, 22 K, 1/4W, 5%		3
R21	200470-088	. RESISTOR, 4.7 K, 1/4W, 5%		2
R22	200470-120	. RESISTOR, 100 K, 1/4W, 5%		4
R23		. (Same As R20)		
R24	200470-112	. RESISTOR, 47 K, 1/4W, 5%		1
R25		. (Same As R20)		
R30	200470-066	. RESISTOR, 560, 1/4W, 5%		1
R31	200470-095	. RESISTOR, 9.1 K, 1/4W, 5%		1
R32		. (Same As R2)		
R33		. (Same As R21)		
R34	200468-061	. RESISTOR, 360, 1/4W, 5%		1
R35,36		. (Same As R22)		
R37		. (Same As R3)		
R38	200470-127	. RESISTOR, 200 K, 1/4W, 5%		1
R39	200054-380	. RESISTOR, 90.9 K, 1/8W, 1%, RN55C		1
R40	200470-122	. RESISTOR, 120 K, 1/4W, 5%		1
R41		. (Same As R9)		
R42		. (Same As R3)		
R43,44		. (Same As R18)		
R45	200470-106	. RESISTOR, 27 K, 1/4W, 5%		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-10				
R46		. (Same As R22)		
R47		. (Same As R11)		
R49,50		. (Same As R3)		
R51	200054-367	. RESISTOR, 66.5 K, 1/8W, 1%, RN55C		1
R52,53	200054-355	. RESISTOR, 49.9 K, 1/8W, 1%, RN55C		2
3	800593-00	. GUIDE, Adjustment (Used with R19)		1
4	90-09255	. LOCTITE, Adhesive		A/R
U1	200056-000	. IC, UA759U1C		1
5	200153-000	. HEATSINK, Aluminum		1
6	800814-02	. INSULATOR, Thermal Conductive ---Attaching Parts		1
7	200476-261	. SCREW, 4-40 X .312, Pan Head		1
8	90-04005	. WASHER, Lock #4		1
9	90-03005	. NUT, Hex, 4-40 ---*---		1
U2	200669-002	. IC, LM339N		1
U3	200875-000	. IC, LM2917		1
U4	2-14409-00	. IC, LM358		1

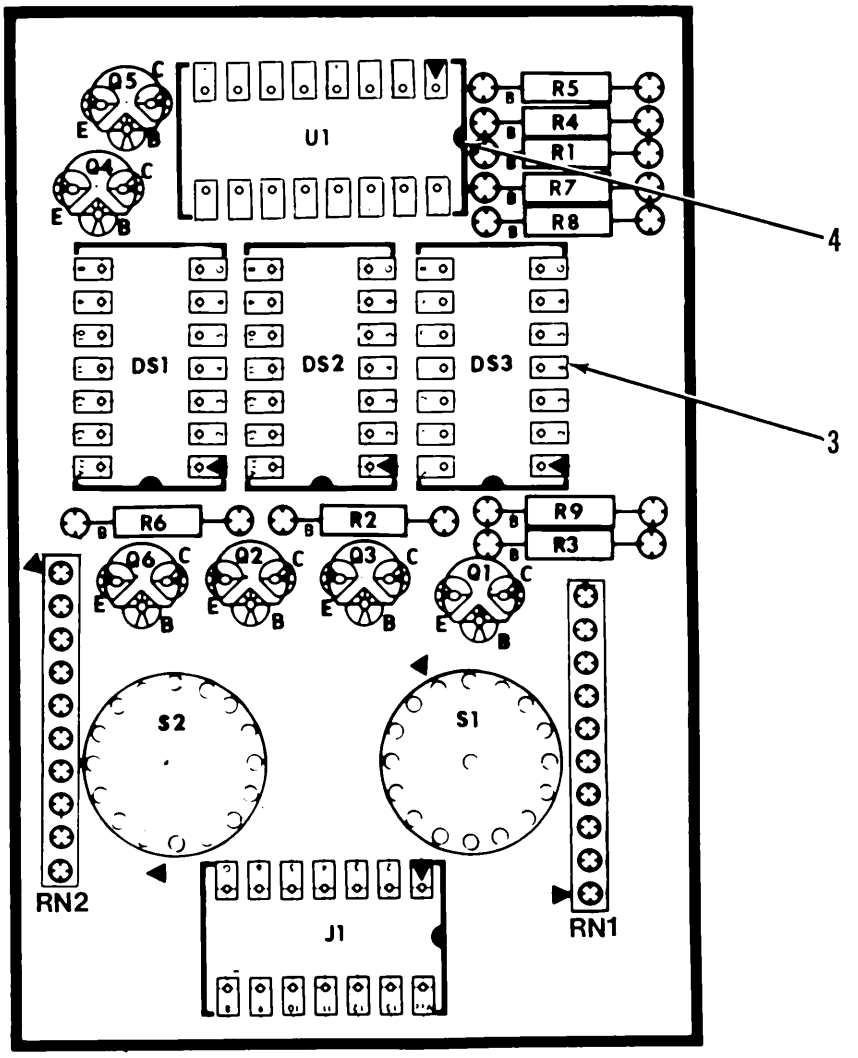


FIGURE 5-11. DISPLAY PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-11				
A9	801904-00	PCB ASSY, Display		REF
2	801903-01	. BOARD, Printed Circuit		1
DS1-3	801957-05	. LED DISPLAY, 7-segment		3
3	200298-01	. SOCKET, IC (Used with DS1-DS3)		3
J1	200907-001	. SOCKET, IC		1
Q1-4	200847-004	. TRANSISTOR, PN3962		4
Q5,6	200986-000	. TRANSISTOR, PN2484		2
R1-3	200470-055	. RESISTOR, 200, 1/4W, 5%		3
R4,5	200470-120	. RESISTOR, 100 K, 1/4W, 5%		2
R6	200470-090	. RESISTOR, 5.6 K, 1/4W, 5%		1
R7	200470-098	. RESISTOR, 12 K, 1/4W, 5%		1
R8	200470-052	. RESISTOR, 150, 1/4W, 5%		1
R9	200470-137	. RESISTOR, 510 K, 1/4W, 5%		1
RN1	800377-01	. RESNET,Multi-value		1
RN2	800377-02	. RESNET, Multi-value		1
S1	200167-023	. SWITCH, Rotary		1
S2	200167-008	. SWITCH, Rotary		1
U1	201274-000	. IC, F9374		1
4	200907-002	. SOCKET, IC		1

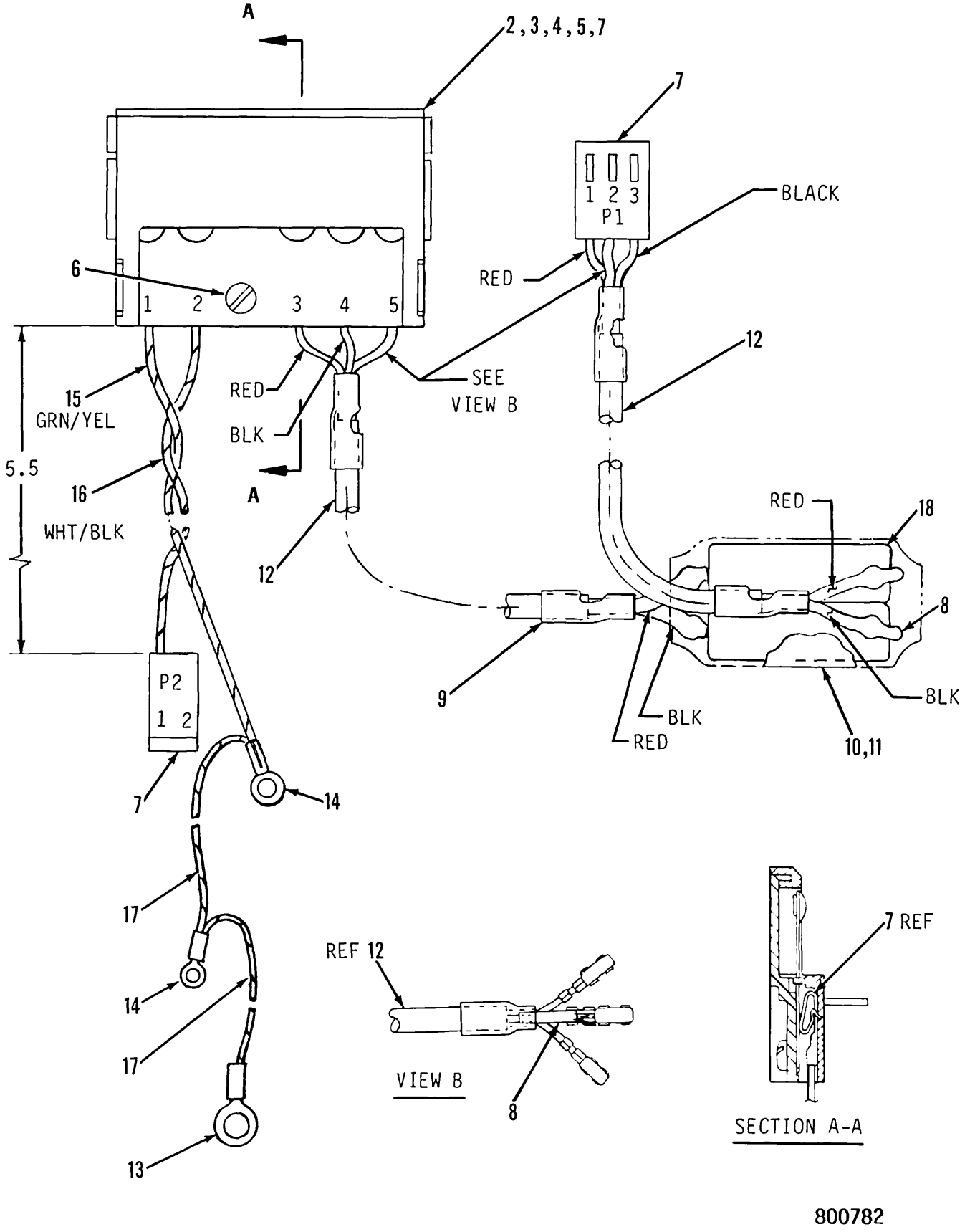


FIGURE 5-12A. INTERCONNECT HARNESS ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-12A				
A10	800782-03	HARNESS ASSY, Interconnect	A	REF
	800782-04	HARNESS ASSY, Interconnect	B	
2	800193-03	. INTERCONNECT ASSY		1
3	800204-00	. . INSULATOR, Outer		1
4	800203-02	. . INSULATOR, Inner		1
5	800365-03	. . CONTACT ASSY		5
		---Attaching Parts		
6	90-01165	. . SCREW, 4-40 X 1/4, PH		1
		---*---		
7	200390-016	. TERMINAL, Crimp #18-24 Chain		10
8	200283-017	. TUBING, Shrink, Black		A/R
9	200283-005	. TUBING, Shrink, Red		A/R
10	200283-022	. TUBING, Shrink, Black	A	A/R
11	200283-008	. TUBING, Shrink, Red	B	A/R
12	200404-042	. CABLE, Shield, CSA		A/R
P1	200277-001	. CONNECTOR Shell		1
P2	200277-000	. CONNECTOR Shell		1
13	200276-238	. LUG Ring		1
14	200276-207	. LUG Ring		2
15	200357-274	. WIRE, Strnd, #22, CSA, Grn/Yel		A/R
16	200357-118	. WIRE, Strnd, #22, CSA, Wht/Blk		A/R
17	200357-272	. WIRE, Strnd, #18, CSA, Grn/Yel		A/R
18	200406-001	. FAULT Interruptor	A	1
	200406-002	. FAULT Interuptor	B	1

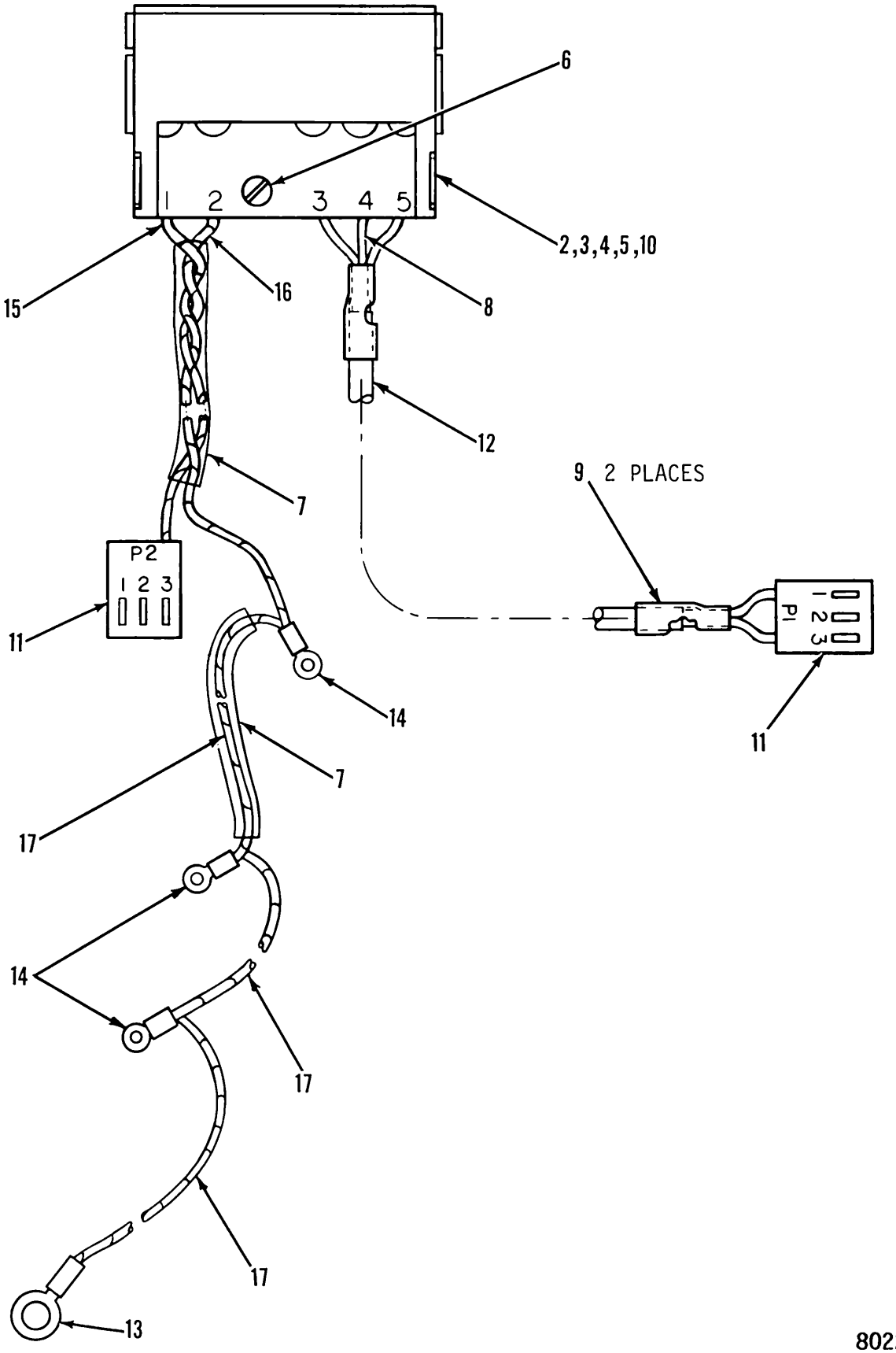


FIGURE 5-12B. INTERCONNECT HARNESS ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-12B				
A10	802240-00	HARNESS ASSY, Interconnect		REF
2	800193-03	. INTERCONNECT ASSY		1
3	800204-00	. . INSULATOR, Outer		1
4	800203-02	. . INSULATOR, Inner		1
5	800365-03	. . CONTACT ASSY ---Attaching Parts		5
6	90-01165	. . SCREW, 4-40 X 1/4, PH ---*---		1
7	90-07023	. TUBING, Clear, #10		A/R
8	200283-017	. TUBING, Shrink, Black		A/R
9	200283-005	. TUBING, Shrink, Red		A/R
10	200390-016	. TERMINAL, Socket		5
11	200390-000	. TERMINAL, Socket		3
12	200404-042	. CABLE, Shield, CSA		A/R
P1,2	200419-020	. CONNECTOR SHELL		2
13	200276-238	. LUG, Ring		1
14	200276-207	. LUG, Ring		3
15	200357-274	. WIRE, Strnd, #22, CSA, Grn/Yel		A/R
16	200357-118	. WIRE, Strnd, #22, CSA, Wht/Blk		A/R
17	200357-272	. WIRE, Strnd, #18, CSA, Grn/Yel		A/R

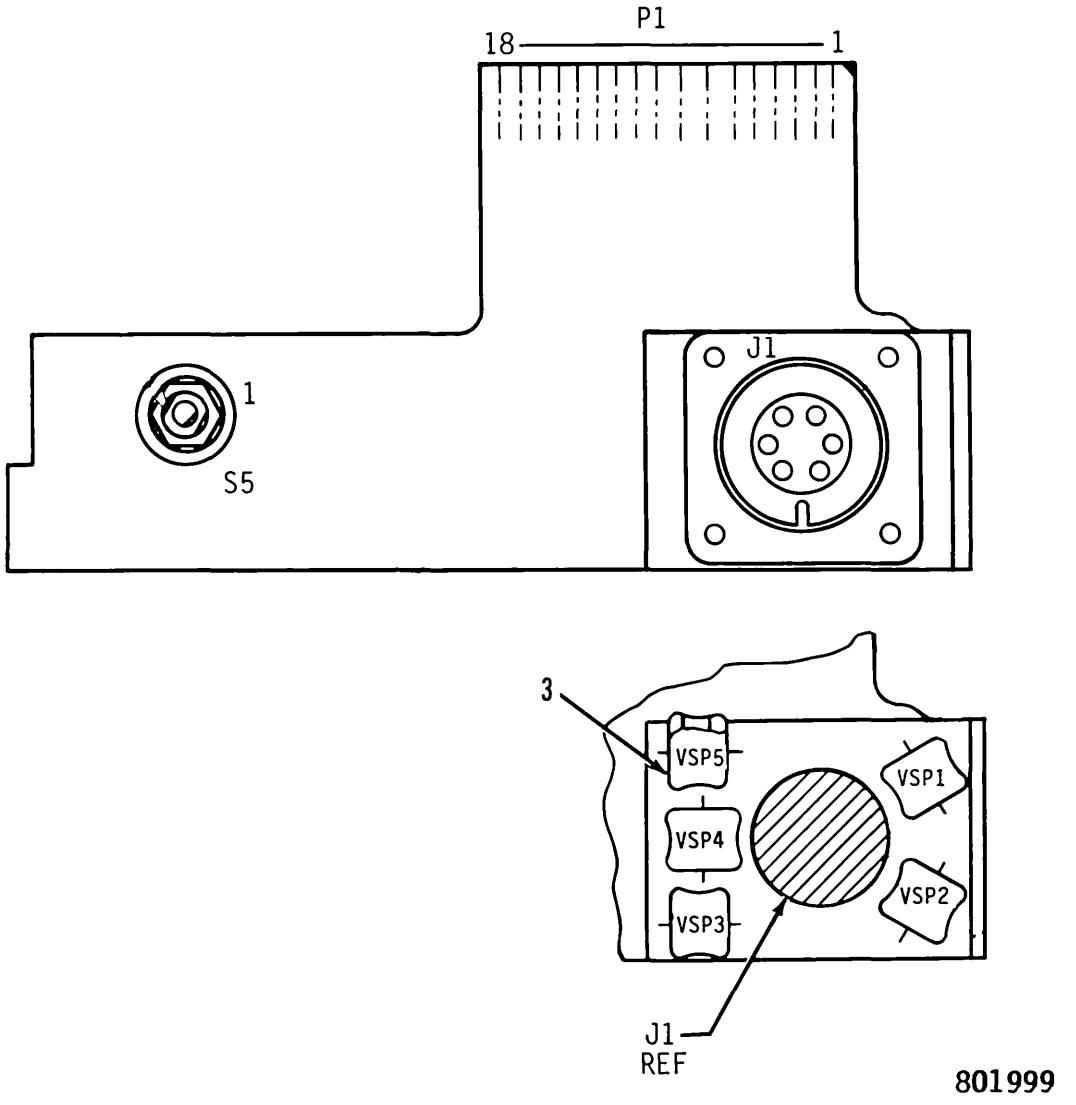


FIGURE 5-13A. ECG PFC ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-13A				
A13	801999-00	PFC ASSY, ECG		REF
2	801998-01	. CIRCUIT, Printed Flex		1
3	200930-006	. TUBING, Heatshrink		A/R
J1	801050-03	. CONNECTOR, Receptacle		1
S5	200151-010	. SWITCH, Rotary		1
VSP1-5	200324-001	. VSP-90, B1-C90/20		5

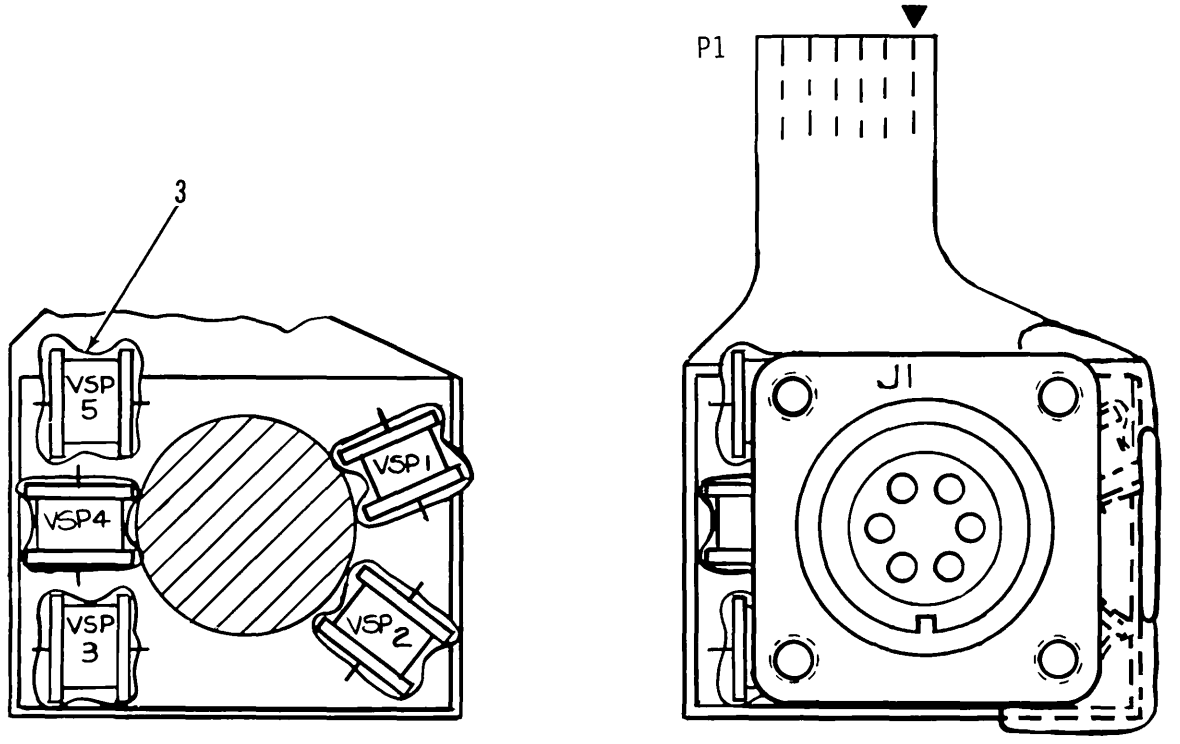


FIGURE 5-13B. ECG PFC ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-13B				
A13	802193-00	PFC ASSY, ECG		REF
2	802192-00	. CIRCUIT, Printed Flex		1
J1	801050-02	. CONNECTOR, Receptacle		1
VSP1-5	200324-001	. VSP-90, B1-C90/20		5
3	200930-006	. TUBING, Heatshrink		A/R

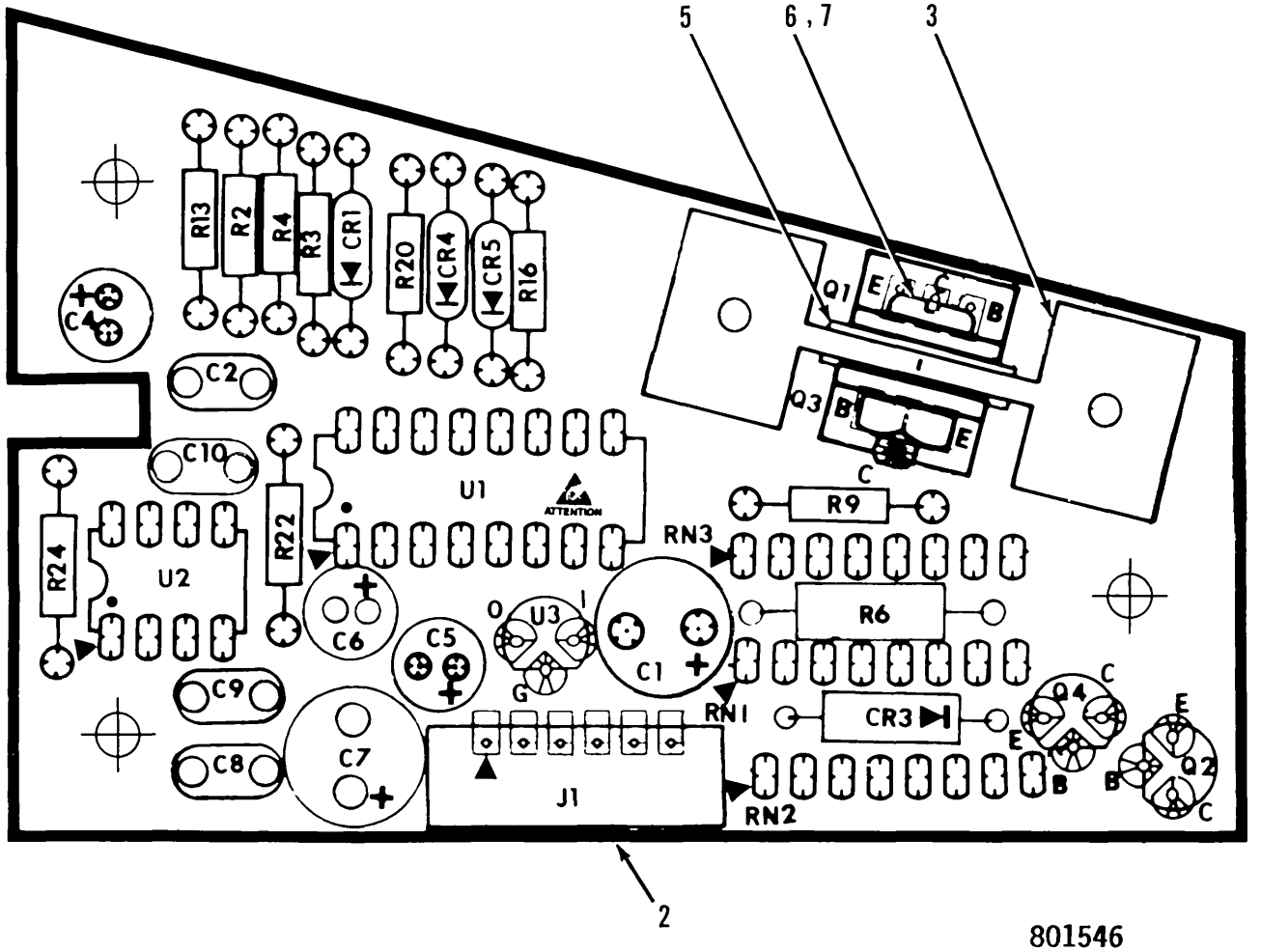


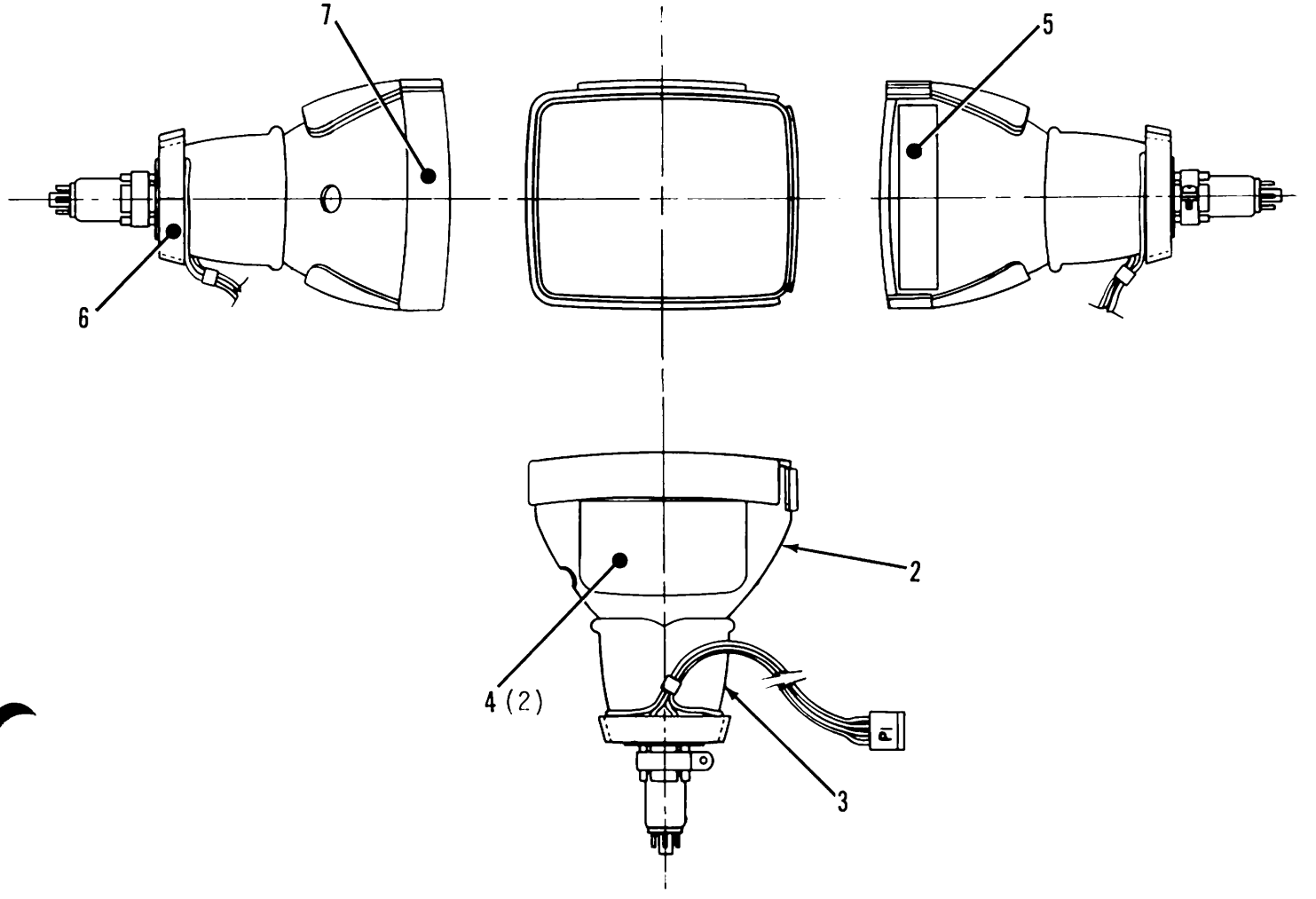
FIGURE 5-14. AAR LOGIC PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-14				
A14	801546-00	PCB ASSY, AAR Logic		REF
2	801545-04	. BOARD, Printed Circuit		1
C1	200205-028	. CAPACITOR, Electrolytic, 100µf/25V, 20%		2
C2	200893-234	. CAPACITOR, .1µf/50V, 20%		4
C4	201317-028	. CAPACITOR, Electrolytic, 10µf/25V, 20%		1
C5,6	201317-053	. CAPACITOR, Electrolytic, 1µf/25V, 20%		2
C7		. (Same As C1)		
C8-10		. (Same As C2)		
CR1	200971-000	. DIODE, 1N914B		3
CR3	200789-003	. DIODE, 30S4		1
CR4,5		. (Same As CR1)		
J1	200073-016	. CONNECTOR, Plug		1
Q1	200621-000	. TRANSISTOR, D45H11		1
Q2	200942-001	. TRANSISTOR, PN2222A		1
Q3	201268-000	. TRANSISTOR, D44H11		1
Q4	200888-001	. TRANSISTOR, PN2907A		1
3	200993-000	. HEATSINK (Soldered)		1
	200993-001	. HEATSINK ---Attaching Parts		1
4	90-01165	. SCREW, 4-40 X 1/4, Pan Head (Not Shown) ---*---		2
5	90-05227	. INSULATOR, Silpad ---Attaching Parts		2
6	201112-042	. SCREW, 4-40 X 5/8, Pan Head		1
7	90-03019	. NUT, 4-40 ---*---		1
R2	200054-256	. RESISTOR, 4.64 K, 1/8W, 1%, RN55C		1
R3	200054-464	. RESISTOR, 681 K, 1/8W, 1%, RN55C		1
R4	200054-480	. RESISTOR, 1 M, 1/8W, 1%, RN55C		2
R6	200471-061	. RESISTOR, 360 1/2W, 5%		1
R9	200471-076	. RESISTOR, 1.5 K, 1/2W, 5%		1
R13	200054-504	. RESISTOR, 1.82 M, 1/8W, 1%, RN55C		1
R16	200470-033	. RESISTOR, 24, 1/4W, 5%		1
R20	200470-120	. RESISTOR, 100 K, 1/4W, 5%		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-14				
R22	200054-281	. RESISTOR, 8.45 K, 1/8W, 1%, RN55C		1
R24		. (Same As R4)		
RN1	201240-012	. NETWORK, Resistor, 4 X 10 K		2
RN2	201240-006	. NETWORK, Resistor, 4 X 1 K		1
RN3		. (Same As RN1)		
U1	200472-000	. IC, 4538B ATTENTION		1
U2	200345-000	. IC, LM393		1
U3	200636-000	. IC, LM340LAZ		1



800632

FIGURE 5-15. CRT ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-15				
A15	800632-00	CRT ASSY		REF
2	800284-00	. TUBE, CRT		1
3	800290-01	. YOKE, CRT		1
4	800631-00	. PAD, Mounting		3
5	200318-13	. TAPE, Neoprene		A/R
6	200318-15	. TAPE, Neoprene		A/R
7	200318-16	. TAPE, Neoprene		A/R

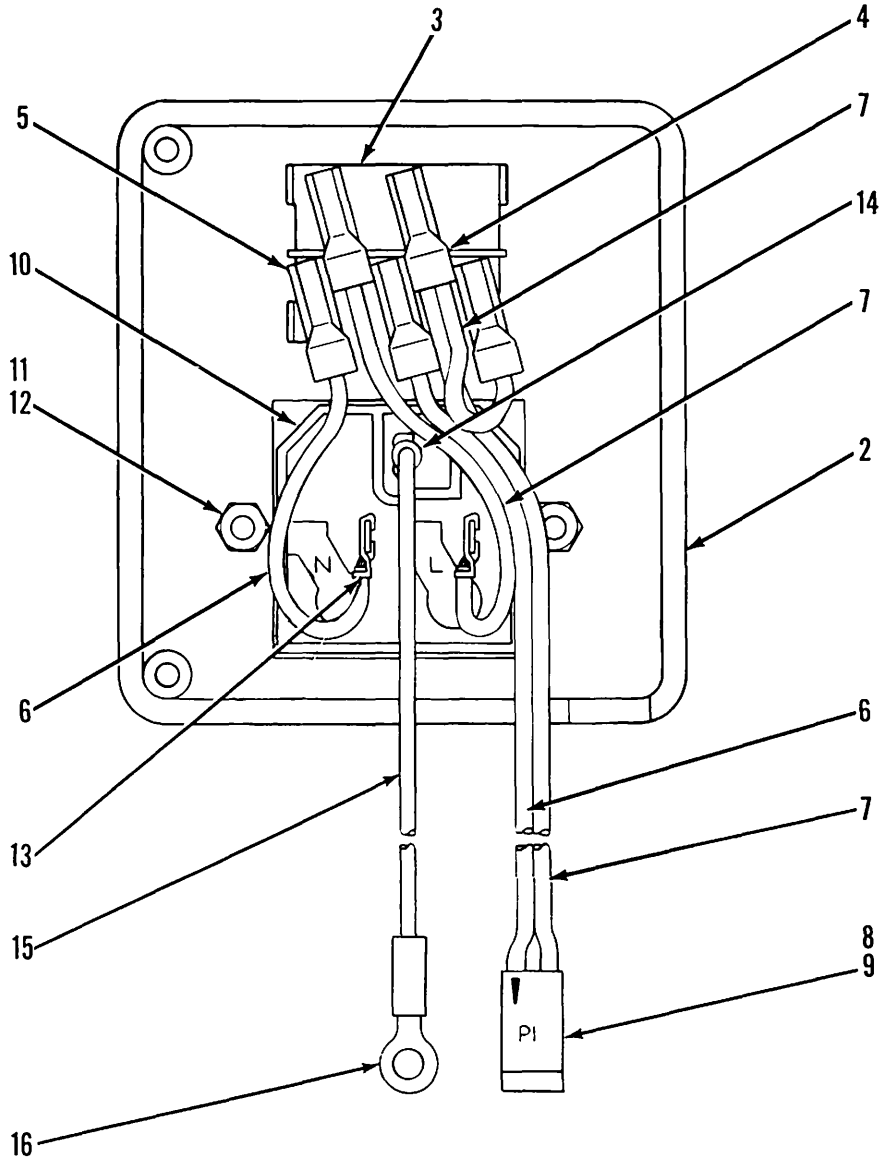


FIGURE 5-16. APPLIANCE CONNECTOR ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-16				
1	800959-01.	CONNECTOR ASSY, Appliance		REF
2	800937-00	. HOUSING, Appliance Connector		1
3	801989-00	. SWITCH, Rocker		1
4	200514-001	. . TERMINAL, Quick Disconnect		1
5	200514-000	. . TERMINAL, Quick Disconnect		4
6	200358-059	. . WIRE, Stranded, #18, Blue		A/R
7	200358-060	. . WIRE, Stranded, #18, Brown		A/R
8	200973-001	. . CONNECTOR, Shell		1
9	02-20241-00	. . TERMINAL, Crimp		2
10	200602-000	. RECEPTACLE, Fuseholder ---Attaching Parts		1
11	90-01236	. SCREW, 4-40 X 7/16, Flat Head		2
12	90-03019	. KEPNUT, 4-40 ---*---		2
13	200598-000	. . TERMINAL, Support		2
14	90-06024	. . LUG, Quick Disconnect		1
15	200358-272	. . WIRE, Stranded, #18, Grn/Yel		A/R
16	90-06069	. . LUG, Ring, #6		1

LEFT BLANK INTENTIONALLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-17				
1	801585-00	FINAL ASSY, DEFIBRILLATOR, 117V/60HZ, 360J	A	REF
	801585-01	FINAL ASSY, DEFIBRILLATOR, 117V/60Hz, 400J	B	
	801585-02	FINAL ASSY, DEFIBRILLATOR, 117V/60Hz, 360J, CSA	C	
	801585-03	FINAL ASSY, DEFIBRILLATOR, 220V/50-60HZ, 360J	D	
	801585-04	FINAL ASSY, DEFIBRILLATOR, 240V/50HZ, 360J	E	
	801585-05	FINAL ASSY, DEFIBRILLATOR, 100V/50-60HZ, 360J	F	
	801585-09	FINAL ASSY, DEFIBRILLATOR, 117V/60HZ, 360J, FRENCH	G	
	801585-10	FINAL ASSY, DEFIBRILLATOR, 220V/50HZ, 360J, FRENCH	H	
	801585-11	FINAL ASSY, DEFIBRILLATOR, 220V/50Hz, 360J, GERMAN	I	
	801585-12	FINAL ASSY, DEFIBRILLATOR, 117V/50HZ, 360J, SPANISH	J	
	801585-13	FINAL ASSY, DEFIBRILLATOR, 220V/50HZ, 360J, SPANISH	K	
	801585-14	FINAL ASSY, DEFIBRILLATOR, 220V/60HZ, 360J, SPANISH	L	
	801585-15	FINAL ASSY, DEFIBRILLATOR, 115V/60HZ, 360J	M	
2	800188-06	. Upper Case Assembly ---Attaching Parts		1
3	200192-026	. STANDOFF, 6-32 X 1		4
4	200475-300	. SCREW, 6-32 X 3/4 Binder Head ---*---		4
5	200130-003	. . LED, Green		1
6	200162-001	. . FASTENER, Right Angle		1
A4	801852-03	. . CONTROL PANEL/PFC ASSY (See Figure 5-18)	A,C,D,E,F	1
	801852-04	. . CONTROL PANEL/PFC ASSY	B	
	801852-06	. . CONTROL PANEL/PFC ASSY	G,H,I,J,K,L	
	801852-07	. . CONTROL PANEL/PFC ASSY ---Attaching Parts	M	
7	200475-293	. . SCREW, 6-32 X 5/16 Binder Head ---*---		3

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-17				
A6	801841-00	. . PCB ASSY, Test Load (See Figure 5-25) ---Attaching Parts		1
8	200475-293	. . SCREW, 6-32 X 5/16 Binder Head ---*---		2
9	800994-01	. . CONTACT ASSY, Test Load ---Attaching Parts		1
10	90-04010	. . WASHER, #6		2
11	90-03021	. . KEPNUT, 6-32 ---*---		2
12	800189-03	. CASE ASSY, Lower ---Attaching Parts		1
13	200475-294	. SCREW, 6-32 X 3/8, Binder Head ---*---		14
14	90-10019	. . MOUNT, Cable Tie		
15	800202-00	. . FOOT, Mounting		2
16	800331-01	. . RETAINER, Paddle		2
17	90-08014	. . TAPE, Foam Adhesive		A/R
18	02-35189-00	. . GROMMET, Continuous		A/R
19	200475-300	. . SCREW, 6-32 X 3/4, Binder Head		1
A1	801820-01	. . PCB ASSY, Main Defib (See Figure 5-24) ---Attaching Parts		1
20	200475-293	. . SCREW, 6-32 X 5/16 Pan Head ---*---		4
21	800250-09	. . PADDLES ASSY, (See Figure 5-26)	A,B,C, F,M	1
	800250-10	. . PADDLES ASSY	D,E	
	800250-11	. . PADDLES ASSY	G,H,I,J, K,L,M	
22	800566-02	. . BATTERY PAK ASSY (B1) ---Attaching Parts		
23	200906-016	. . TAPE, Neophrene, 3/4 X 1/8		A/R
24	90-08014	. . TAPE, Foam, 3/4 X 1/4 ---*---		A/R
A3	800240-02	. RELAY ASSY, Transfer ---Attaching Parts		1
25	200531-016	. SCREW, 6-19 X .5L, Self Tap ---*---		4

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-17				
26	801837-03	. WIRING HARNESS ASSY,Defib(See Figure 5-21)	A,B,D,E,F,H,I,K,L,M	1
	801837-04	. WIRING HARNESS ASSY, Defib ---Attaching Parts	C,G	
27	201105-538	. SCREW, 4-40 X .375, Flat Head		1
28	90-03019	. KEPNUT, Hex, 4-40 X .250W ---*---		1
29	800201-02	. BRACKET ASSY		1
30	200175-310	. SCREW, 6-32 X 1 3/8, Binder Head		1
A5	801844-01	. METER ASSY, Energy ---Attaching Parts		1
31	200475-294	. SCREW, 6-32 X 3/8, Binder Head ---*---		2
32	800196-00	. CLOSURE LATCH		1
33	800198-00	. SPRING LATCH		1
34	800515-02	. INDUCTOR, 28mH, 12 ohms, 6KVDC (L1)		1
35	800339-02	. CAPACITOR, 36µf/6KV (C1)		1
36	801533-00	. . LABEL, Hi Voltage		3
37	800890-00	. . LABEL, Caution Hi Voltage		2
38	801021-02	. . INSULATOR, Aramid Paper		1
39	802020-00	. . INSULATOR, Aramid Paper ---Attaching Parts		1
40	200906-016	. . TAPE, Neophrene, 3/4W X 1/8T		A/R
41	90-08017	. . TAPE, Foam, 1/2W X .01T		A/R
42	800516-01	. RESISTOR ASSY (R1)		1
A2	800041-12	. PCB ASSY, Charger (See Figure 5-22)	D,H,I,K,L	1
	800041-13	. PCB ASSY, Charger	E	
	800041-15	. PCB ASSY, Charger	A,B,J	
	800041-16	. PCB ASSY, Charger	M	
	800041-17	. PCB ASSY, Charger	F	
	801506-08	. CHARGER ASSY	C,G	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-17				
43	801965-00	. . LABEL, Caution, English	A,B,F,M	1
	801965-02	. . LABEL, Caution, Spanish	J	
	801965-04	. . LABEL, Caution, French	H	
	801965-05	. . LABEL, Caution, German	I	
	801965-06	. . LABEL, Caution, Spanish	K	
	801965-07	. . LABEL, Caution, English	E	
	801965-09	. . LABEL, Caution, Spanish	L	
	801965-10	. . LABEL, Caution, English/French	C,G	
	801965-11	. . LABEL, Caution, English ---Attaching Parts	D	
44		. SCREW, 6-32 X 5/16, Pan Head ---*---		4
45	200126-001	. KNOB, Instrument		1
46	801916-00	. LABEL, Front Panel, 360J, English	A,C,D,E,F	1
	801916-01	. LABEL, Front Panel, 400J English	B	
	801916-02	. LABEL, Front Panel, 360J, French	G,H	
	801916-03	. LABEL, Front Panel, 360J, German	I	
	801916-04	. LABEL, Front Panel, 360J, Spanish	J,J,L	
	801916-05	. LABEL, Front Panel, AC Only, 360J, English	M	
47	800216-00	. LABEL, Explosion Hazard, English	A-F,M	1
	800216-02	. LABEL, Explosion Hazard, French	G,H	
	800216-03	. LABEL, Explosion Hazard, German	I	
	800216-04	. LABEL, Explosion Hazard, Spanish	J-L	
48	801915-01	. LABEL, Operating Instructions, French	G,H	1
	801915-02	. LABEL, Operating Instructions, German	I	
	801915-03	. LABEL, Operating Instructions, Spanish	J-L	
	801915-04	. LABEL, Operating Instructions,English Int'l	D-F	
	801915-05	. LABEL, Operating Instructions, English	A-C,M	
49	801914-00	. LABEL, Instruction, 360J, English	A,C-F,M	1
	801914-01	. LABEL, Instruction, 400J, English	B	
	801814-02	. LABEL, Instruction, 360J, French	G,H	
	801914-03	. LABEL, Instruction, 360J, German	I	
	801914-04	. LABEL, Instruction, 360J, Spanish	J-L	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-17				
50	800896-04	. LABEL, Serial Number, CSA, French	G	1
	800896-05	. LABEL, Serial Number, French	H	
	800886-06	. LABEL, Serial Number, German	I	
	800896-07	. LABEL, Serial Number, Spanish	K,L	
	800896-08	. LABEL, Serial Number, Spanish	J	
	800896-10	. LABEL, Serial Number, English, Int'l	D,E	
	800896-11	. LABEL, Serial Number, English	A,B,F,M	
51	800360-05	. LABEL, Warning, CSA	B	1
	800360-06	. LABEL, Warning, CSA	G	
52	800746-00	. LABEL, Trim Dot		1
53	801362-03	. LABEL, Fuse Warning		1
54	800941-00	. LABEL, Fuse	K	
	800941-01	. LABEL, Fuse	E	
	800941-02	. LABEL, Fuse	L	
	800941-06	. LABEL, Fuse	H	
	800941-07	. LABEL, Fuse	I	
	800941-12	. LABEL, Fuse	D	
55	800944-00	. LABEL, Mains Power, English	D,E	1
	800944-03	. LABEL, Mains Power, French	H	
	800944-04	. LABEL, Mains Power, German	I	
	800944-05	. LABEL, Mains Power, Spanish	K,L	

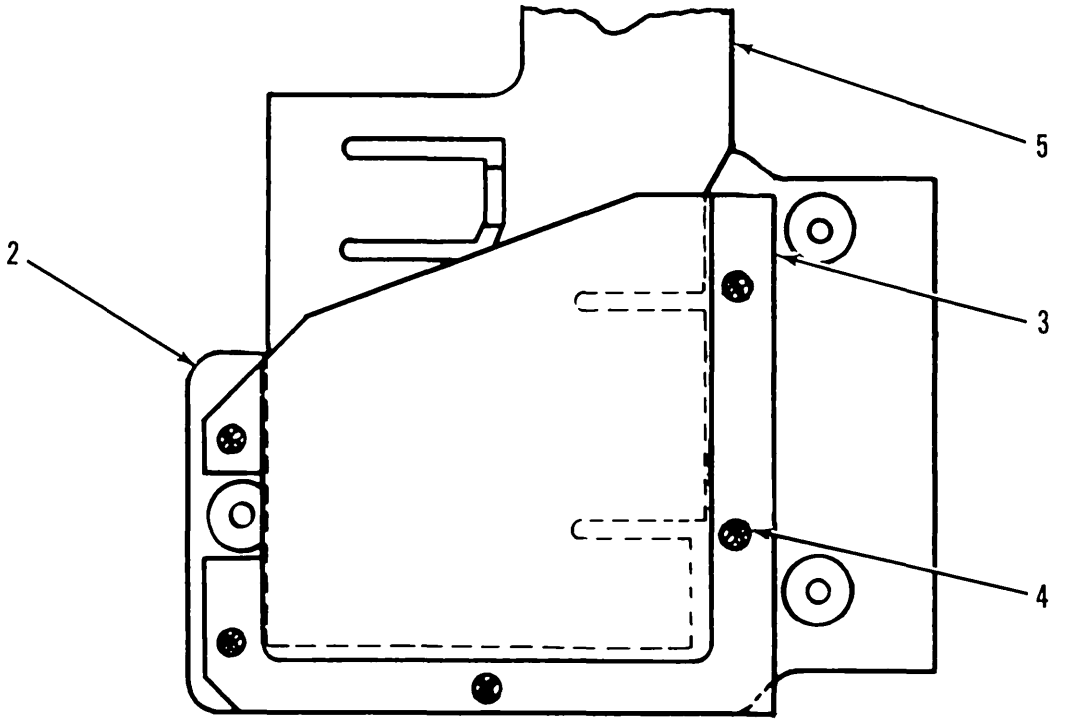


FIGURE 5-18. CONTROL PANEL/PFC ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-18				
1	801852-03	CONTROL PANEL/PFC ASSY	A	REF
	801852-04	CONTROL PANEL/PFC ASSY	B	
	801852-05	CONTROL PANEL/PFC ASSY	C	
	801852-06	CONTROL PANEL/PFC ASSY	D	
	801852-07	CONTROL PANEL/PFC ASSY	E	
2	801851-01	. PANEL ASSY, Control	A,B,E	1
	801851-03	. PANEL ASSY, Control	C	
	801851-04	. PANEL ASSY, Control	D	
3	801006-00	. . COVER ENCLOSURE, Control ---Attaching Parts		1
4	200531-001	. . SCREW, 4-24 X .250L, Pan Head ---*---		5
5	801848-02	. PFC ASSY, Control	A,C,D	1
	801848-03	. PFC ASSY, Control	B	
	801848-04	. PFC ASSY, Control	E	

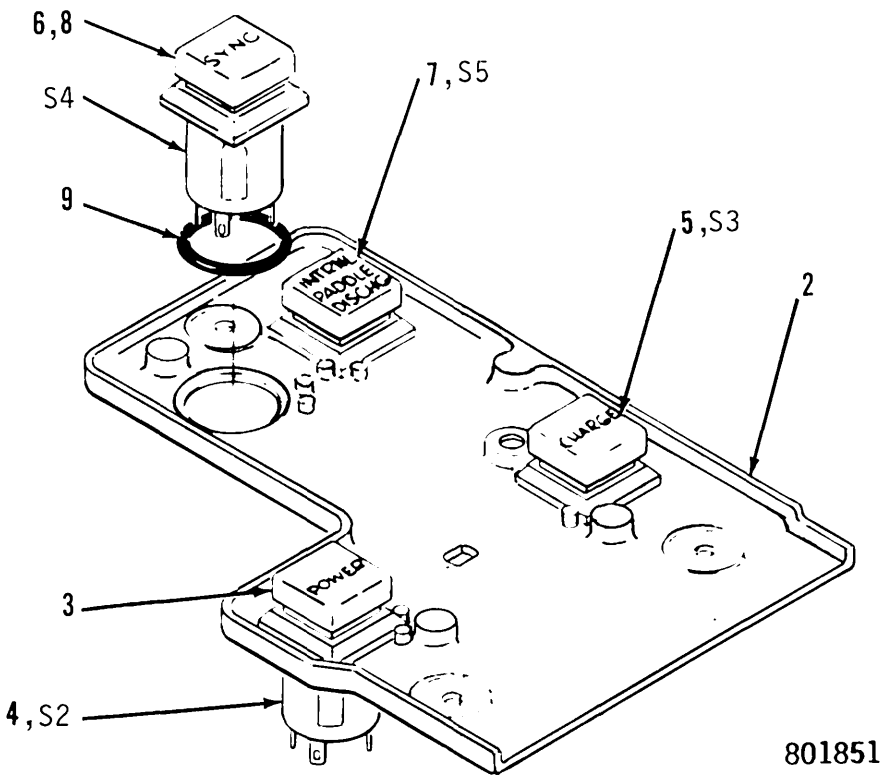


FIGURE 5-19. CONTROL PANEL ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-19				
1	801851-02	PANEL ASSY, Control	A	REF
	801851-03	PANEL ASSY, Control	B	
	801851-04	PANEL ASSY, Control	C	
2	801423-03	. SUPPORT PANEL, Control		1
S2	201332-000	. SWITCH ASSY, Pushbutton		1
3	802010-00	. . SWITCH (Green)	B	1
	801438-01	. . SWITCH (Green)	A	
4	200132-000	. . LAMP, 14V, .06A		1
S3-S5	200128-000	. SWITCH ASSY, Pushbutton		3
5	800494-04	. . SWITCH (Amber) (Used on S3)	A,B	1
6	800494-00	. . SWITCH (White) (Used on S4)	A,B	1
7	800494-03	. . SWITCH (Black) (Used on S5)	A,B	1
8	200132-001	. . LAMP, 14V, .08A (Used on S3, S4)		2
9	200060-002	. . O-RING (Used on S3, S4, S5)		3

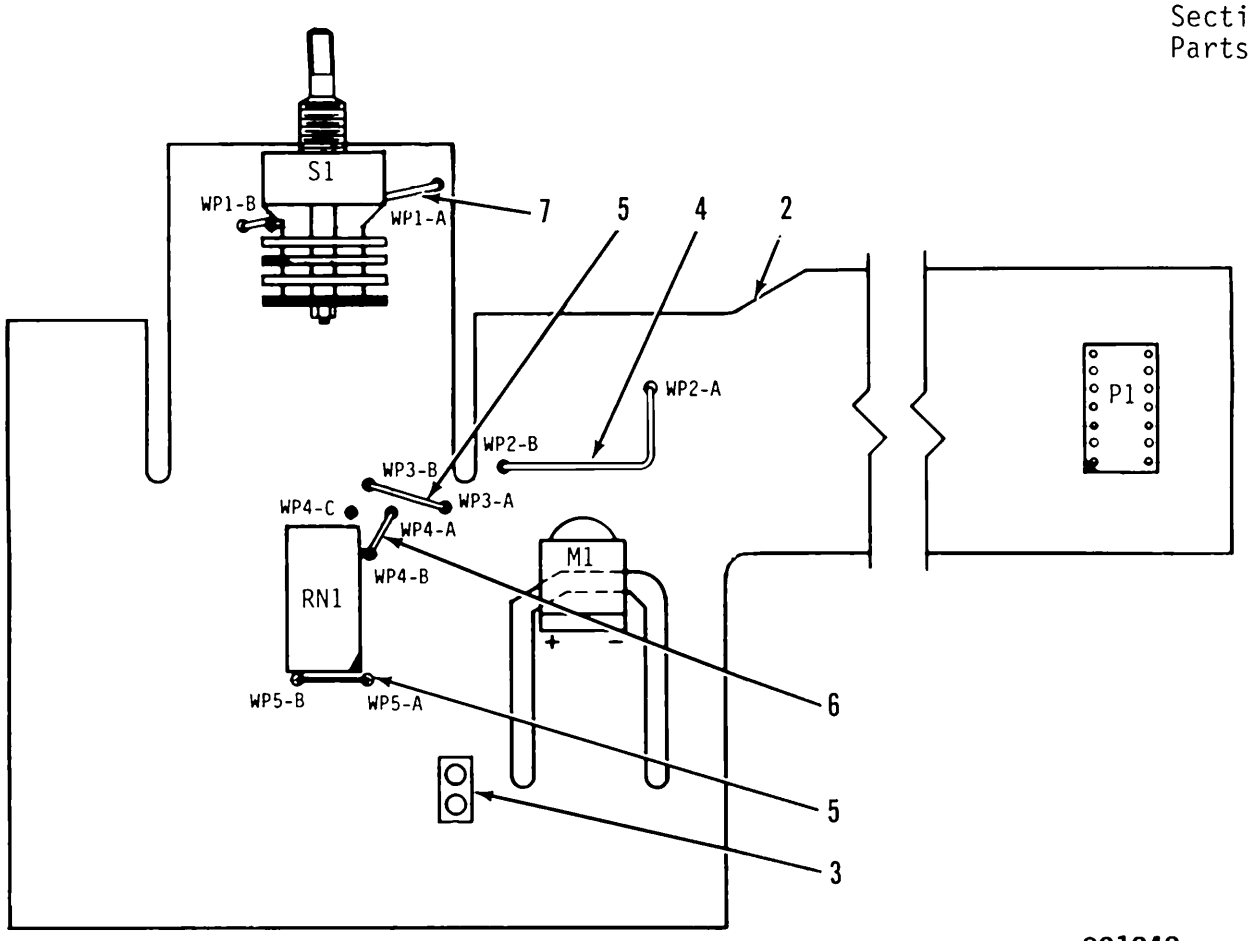


FIGURE 5-20. CONTROL PFC ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-20				
1	801848-02	PFC ASSY, Control	A	REF
	801848-03	PFC ASSY, Control	B	
	801848-04	PFC ASSY, Control	C	
2	801847-02	. CONTROL DEFIB FLEX CIRCUIT		1
	801847-03	. CONTROL DEFIB FLEX CIRCUIT		1
3	201285-034	. CONNECTOR Receptacle	A,B	2
M1	200129-000	. METER, .85VDC, 5mA	A,B	1
P1	200189-004	. CONNECTOR, DIP, 14-pin		1
RN1	801832-00	. RESNET		1
S1	801854-00	. ROTARY SWITCH, 10 pos, 115V		1
4	201301-608	. JUMPER WIRE, .450L, 22 AWG(WP2A to WP2B)		1
5	201301-607	. JUMPER WIRE, .400L, 22 AWG(WP5A to WP5B)		1
6	201301-604	. JUMPER WIRE, .250L, 22 AWG(WP4A to WP4B)		1
7	201301-621	. JUMPER WIRE, 1.10L, 22 AWG(WP1A to WP1B)		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-21				
1	801837-03	WIRING HARNESS ASSY	A	REF
	801837-04	WIRING HARNESS ASSY	B	
J1	801838-01	. CONNECTOR ASSY		1
J7	800193-03	. INTERCONNECT ASSY		1
2	800365-03	. . CONTACT ASSY		5
3	800204-00	. . OUTER INSULATOR		1
4	800203-02	. . INNER INSULATOR ---Attaching Parts		1
5	90-01165	. . SCREW, 4-40 X 1/4 Pan Head ---*---		1
P1	200277-003	. CONNECTOR, 5-contact	A	1
	200277-005	. CONNECTOR, 7-contact	B	
P2 & 3	200277-006	. CONNECTOR, 8-contact,		2
P5	90-06063	. TERMINAL LUG		1
P6	200277-000	. CONNECTOR, 2-contact,		1
P7	200277-002	. CONNECTOR, 4-contact		1
P8	200277-000	. CONNECTOR (Same As P6)		1
6	200404-042	. CABLE, Shield, #22 Strnd, 300V, CSA		A/R
7	802069-00	. CABLE, Shield, #22 Strnd, 20KV		A/R
8	200267-000	. LUG, Terminal, Quick Disc, #18-22 Red		9
9	200390-016	. SOCKET, Terminal, #18-24 Chain		35
10	200515-004	. LUG, Terminal, Slip on, .225W X .020T		2
11	200514-000	. TERMINAL, Quick Disc, 22-18 AWG		1
12	90-06053	. TERMINAL HOUSING, Slip on, .250W		1
13	200357-008	. WIRE, Stranded, #18, 300V, CSA, Yellow		A/R
14	200357-065	. WIRE, Stranded, #18, 300V, CSA, Wht/Red		A/R
15	200357-108	. WIRE, Stranded, #22, 300V, CSA, White		A/R
16	200357-109	. WIRE, Stranded, #22, 300V, CSA, Black		A/R
17	200357-112	. WIRE, Stranded, #22, 300V, CSA, Yellow		A/R
18	200357-113	. WIRE, Stranded, #22, 300V, CSA, Blue		A/R
19	200357-115	. WIRE, Stranded, #22, 300V, CSA, Orange		A/R
20	200357-117	. WIRE, Stranded, #22, 300V, CSA, Violet		A/R
21	200357-121	. WIRE, Stranded, #22, 300V, CSA, Wht/Yel		A/R

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-21				
22	200357-123	. WIRE, Stranded, #22, 300V, CSA, Wht/Brn		A/R
23	200624-005	. TUBING, Teflon, Thin wall, .034 ID		A/R
24	200624-023	. TUBING, Teflon, Thin wall, .263 ID		A/R
25	200283-005	. TUBING, Heat Shrink, .250 ID		A/R
26	200283-007	. TUBING, Heat Shrink, .500 ID		A/R

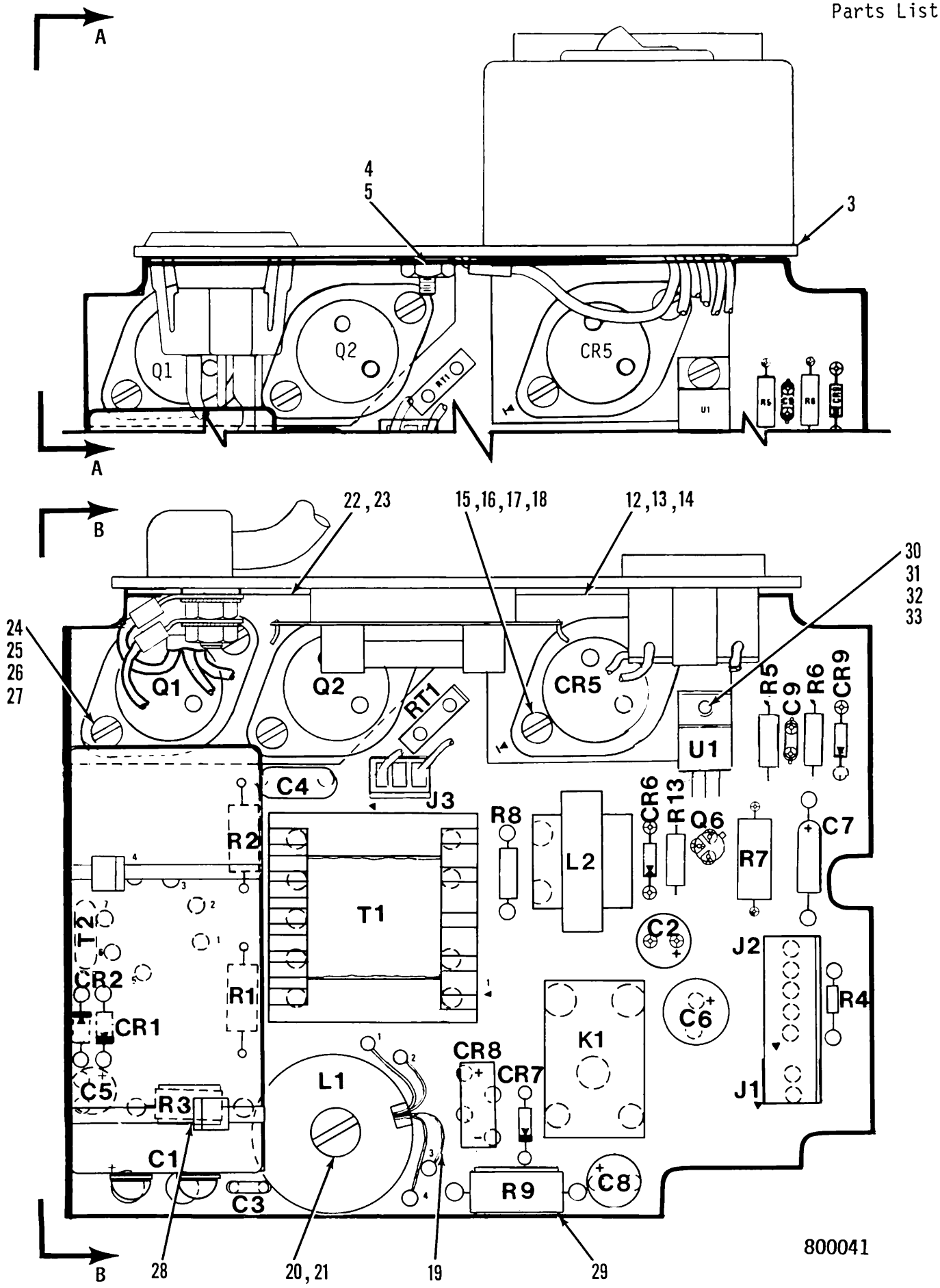
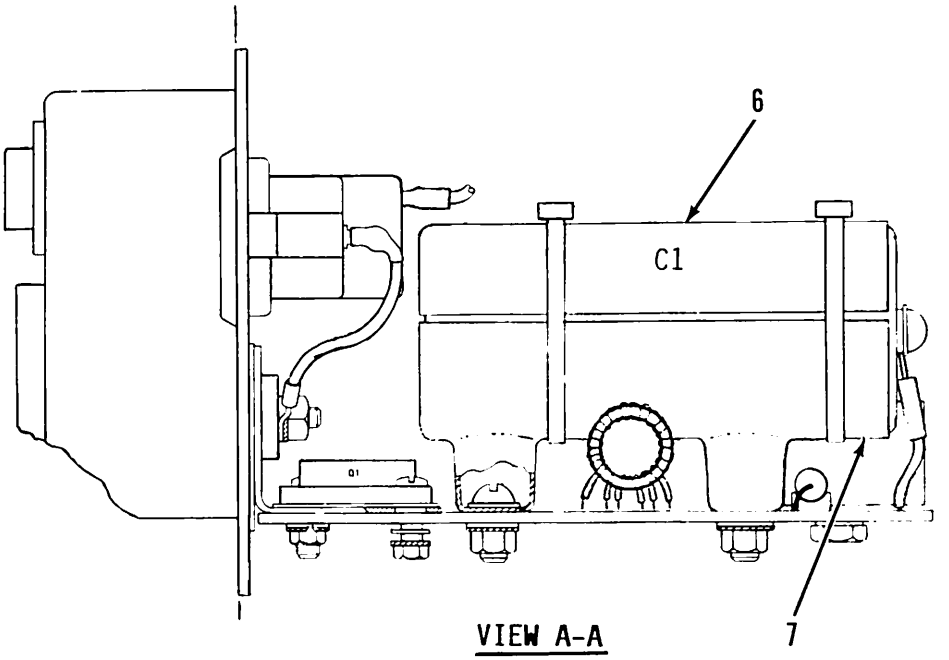
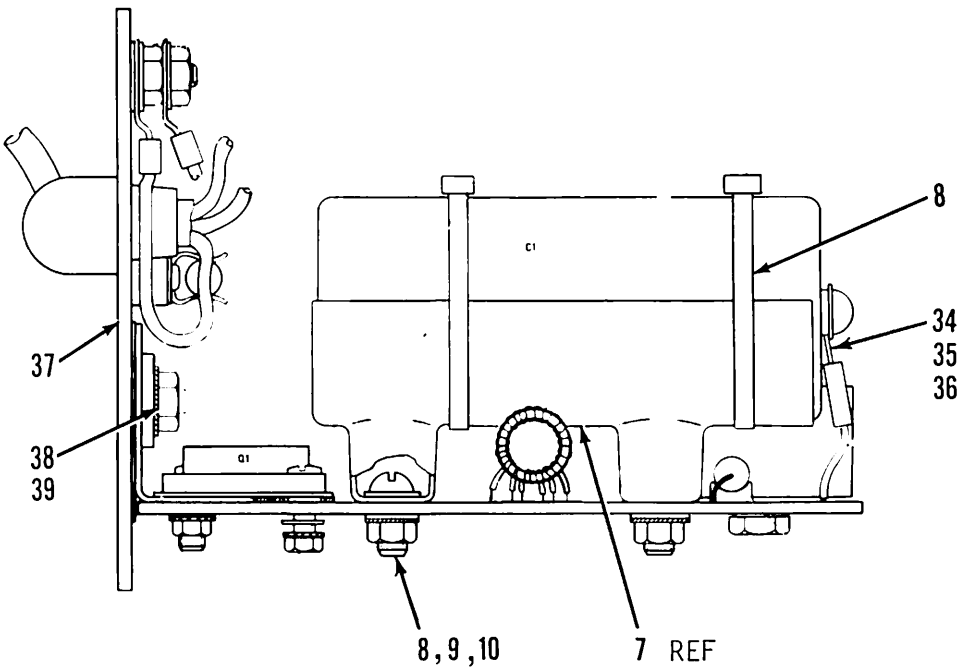


FIGURE 5-22A. CHARGER PCB ASSEMBLY, DEFIB

(SHEET 1 OF 2)



VIEW A-A



VIEW B-B

FIGURE 5-22A. CHARGER PCB ASSEMBLY, DEFIB
(SHEET 2 OF 2)

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-22A				
1	800041-12	PCB ASSY, Charger, Defib	A	REF
	800041-13	PCB ASSY, Charger, Defib	B	
	800041-15	PCB ASSY, Charger, Defib	C	
	800041-16	PCB ASSY, Charger, Defib	D	
	800041-17	PCB ASSY, Charger, Defib	E	
	800041-18	PCB ASSY, Charger, Defib	F	
2	800040-09	. BOARD, Printed Circuit		1
3	800960-00	. APPLIANCE CONNECTOR ASSY ---Attaching Parts	A,B	1
4	800859-01	. WASHER, #8, Nylon		1
5	90-03024	. KEPNUT, 8-32 ---*---		2
C1	200010-122	. CAPACITOR, Electrolytic, 160µf/450V	A,B	1
	200100-100	. CAPACITOR, Electrolytic, 500µf/250V	C,D,E,F	
6	800858-02	. CAPACITOR, Cover Enclosure	A,B	1
7	800858-01	. CAPACITOR, Insulator Mount ---Attaching Parts		1
8	90-10012	. RETAINER, Cable Tie		2
9	90-01168	. SCREW, 10-32 X .375, Round Head		2
10	90-04019	. WASHER, Flat, #10 X .675 OD/.020T		4
11	90-03023	. KEPNUT, 10-32 ---*---		2
C2	200322-060	. CAPACITOR, Electrolytic 22µf/50V	A,B,C,E,F	1
C3	200507-030	. CAPACITOR, .01µf/1KV		1
C4	200362-024	. CAPACITOR, .1µf/100V	A,B	1
	200362-020	. CAPACITOR, .047µf/100V	C,D,E,F	
C5	200090-006	. CAPACITOR, Tantalum, 330µf/3V		1
C6	200322-004	. CAPACITOR, Electrolytic, 270µf/25V		1
C7	200546-151	. CAPACITOR, Tantalum, 2.2µf/50V	A,B,C,E,F	1
C8	200205-075	. CAPACITOR, Electrolytic, 22µf/100V		1
C9	200264-018	. CAPACITOR, .1µf/50V		1

PARTS LIST

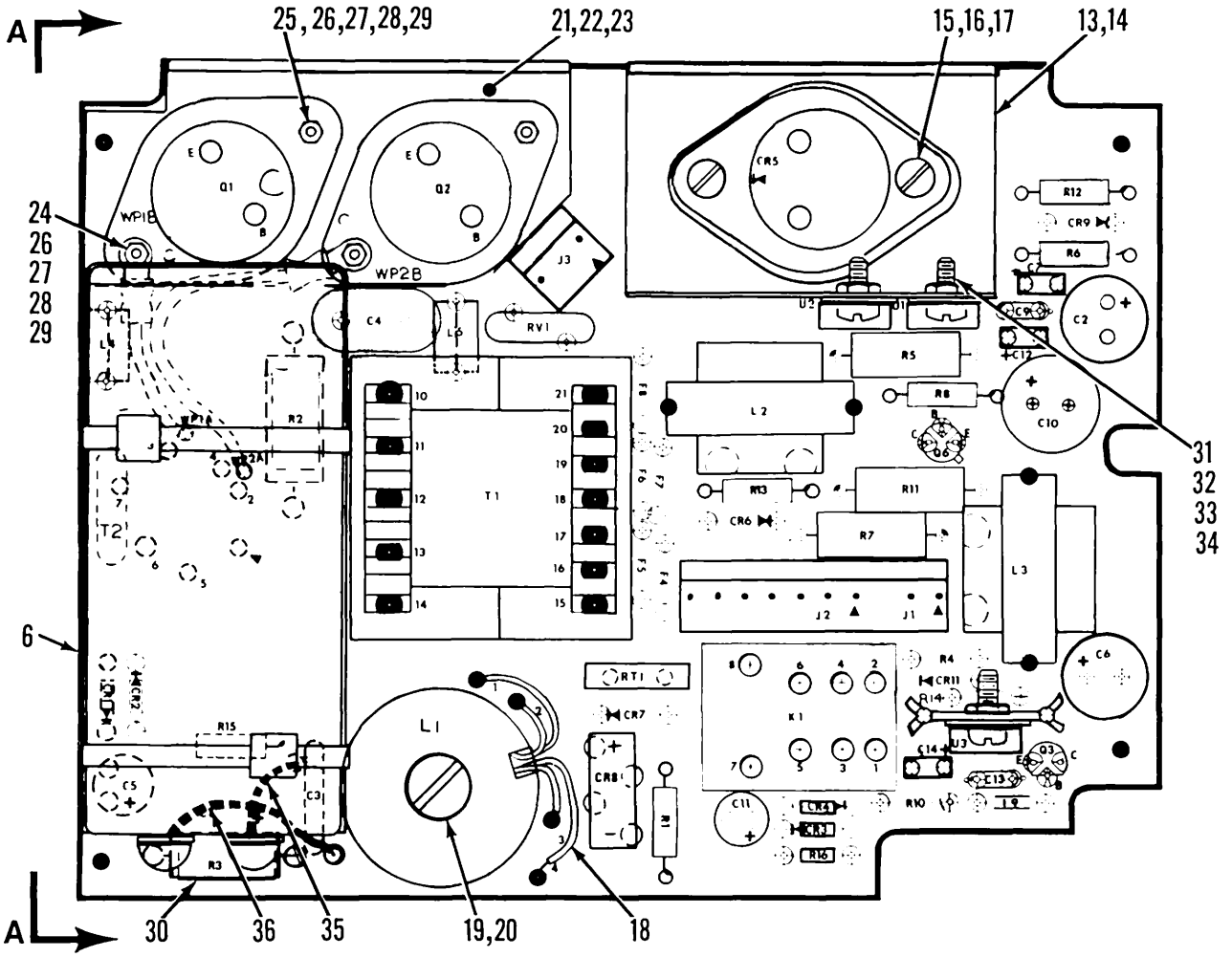
FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-22A				
CR1	200658-002	. DIODE, 200NS, PIV200		1
CR2	200658-002	. DIODE, 200NS, PIV200		1
CR5	200498-002	. DIODE, Dual VSK3040T		1
12	800857-02	. . HEATSINK		1
13	801496-01	. . INSULATOR, Silpad	A,B,C, E,F	1
14	90-09106	. . INSULATOR, Silpad ---Attaching Parts	D	1
15	200475-264	. . SCREW, 4-40 X .500L, Binder Head		2
16	90-04004	. . FIBER WASHER, #4 X .250 OD/ .060T		2
17	90-04008	. . FLAT WASHER, #4 X .312 OD/.020T		2
18	90-03019	. . KEPNUT, 4-40 ---*---		2
CR6	200658-002	. DIODE, 200NS, PIV200	A,B,C, E,F	1
CR7	200284-005	. DIODE, IN4005		
CR8	200499-028	. DIODE, FWLC1000	A,B	1
	200499-026	. DIODE, FWLC600	C,D,E,F	1
CR9	200658-002	. DIODE, 200NS, PIV200	A,B,C, E,F	1
F1,2	200619-016	. FUSE, Slow, 1.25A/250V	A,B	2
K1	200542-000	. RELAY, 48VDC, 10A		1
L1	800210-00	. INDUCTOR, RFI		1
19	200624-004	. . TUBING, Teflon, .027ID, Thin wall ---Attaching Parts		A/R
20	NO NUMBER	. . SCREW, 10-32 X 1.000L		1
21	NO NUMBER	. . NUT, Cad-plated 10-32 ---*---		1
L2	800328-00	. INDUCTOR, Filter Choke		1
Q1,2	201343-000	. TRANSISTOR, MJ12003	A,B	2
	800180-00	. TRANSISTOR, DTS423, Matched	C,D,E,F	2
22	800856-01	. . HEATSINK		1
23	90-09106	. . INSULATOR, Silpad ---Attaching Parts		2

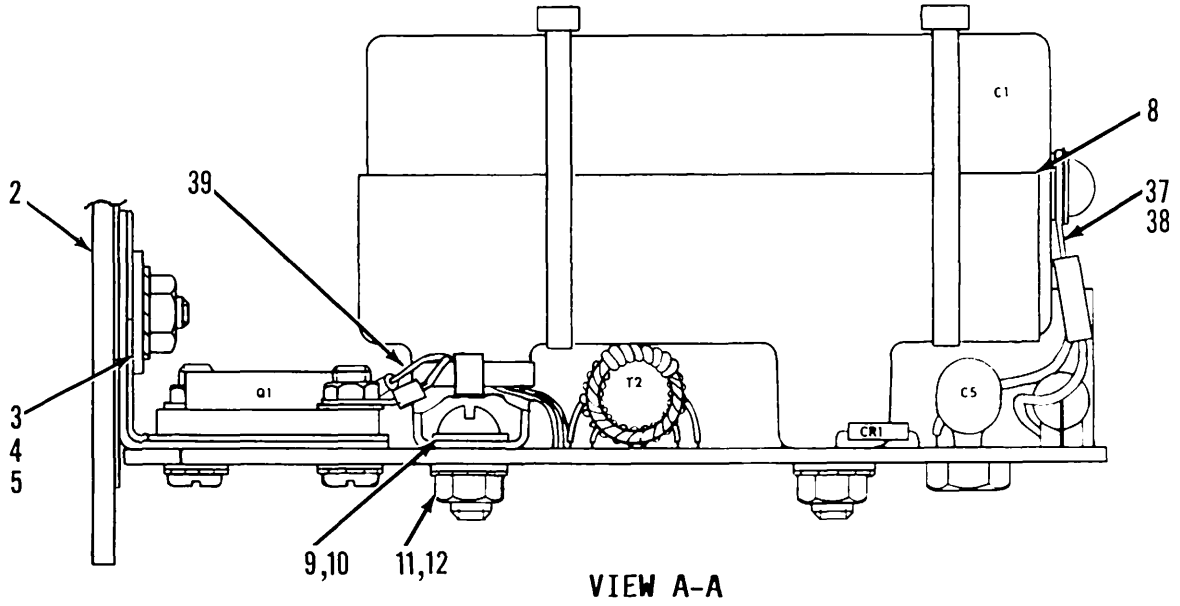
PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-22A				
24	200475-264	. . SCREW, 4-40 X .500L		4
25	90-04004	. . WASHER, Fiber, #4 X .250 OD/.060T		4
26	90-04008	. . WASHER, Flat, #4 X .312 OD/.020T		4
27	90-03019	. . KEPNUT, 4-40		4
		---*---		
Q6	200888-003	. TRANSISTOR, 2N2907A	A,B,C, E,F	1
R1	200120-118	. RESISTOR, 250 K, 5%	A	1
	200120-120	. RESISTOR, 270 K, 5%	B	
	200120-106	. RESISTOR, 68 K, 5%	C,D,F	
	200120-102	. RESISTOR, 47 K, 5%	E	
R2	200121-041	. RESISTOR, 100, 1%	A,B	1
	200121-047	. RESISTOR, 150, 1%	C,D,E,F	
R3	200270-015	. RESISTOR, .43, 5%		1
28	90-09089	. INSULATOR MOUNT		1
R4	200470-068	. RESISTOR, 680, 5%	A,B,C, E,F	1
R5	200124-024	. RESISTOR, 10, 5%	A,B,C, E,F	1
R6	200124-026	. RESISTOR, 12, 5%	A,B,C, E,F	1
R7	200120-071	. RESISTOR, 2.4 K, 5%	A,B,C, E,F	1
R8	200124-030	. RESISTOR, 18, 5%		1
R9	200257-074	. RESISTOR, 12 K, 5%	A	1
	200257-076	. RESISTOR, 15 K, 5%	B	
	200257-063	. RESISTOR, 4.3 K	C,D,F	
	200207-060	. RESISTOR, 3.3 K, 5%	E	
29	90-09089	. INSULATOR MOUNT		1
R13	200124-000	. RESISTOR, 1, 5%	A,B,C, E,F	1
RT1	200486-003	. THERMISTOR, 5, 2A		1
T1	801033-01	. TRANSFORMER, Power, 220V	A	1
	801034-01	. TRANSFORMER, Power, 240V	B	
	801032-02	. TRANSFORMER, Power, 115V	C,D	

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-22A				
	801031-01	. TRANSFORMER, Power, 100V	E	
	801032-03	. TRANSFORMER, Power, 115V	F	
T2	800329-01	. TRANSFORMER, Feedback		1
U1	200414-000	. VOLTAGE REGULATOR, 2M317	A,B,C, E,F	
		---Attaching Parts		
30	90-01235	. SCREW, Nylon 4-40 X .500L		1
31	90-04004	. WASHER, Fiber #4 X .250 OD/.060T		1
32	90-04008	. WASHER, Flat #4 X .312 OD/.020T		1
33	90-03019	. KEPNUT, 4-40 ---*---		1
J1,2	200096-006	. CONNECTOR		1
J3	2-20324-00	. CONNECTOR		1
34	200358-060	. WIRE, Stranded, #18, 600V, CSA, Brown ---Attaching Parts		A/R
35	90-06043	. TERMINAL LUG, #10 AWG, Red		2
36	90-04018	. LOCKWASHER, #10 ---*---		2
37	801563-00	. HEATSINK ASSY ---Attaching Parts	C,D,E,F	1
38	800859-01	. NYLON WASHER, #8 X .400 OD/.068T		1
39	90-03024	. KEPNUT, 8-32 ---*---		2





VIEW A-A

801506

FIGURE 5-22B. CHARGER ASSEMBLY , DEFIB

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-22B				
1	801506-08	CHARGER ASSY		REF
2	801563-01	. HEATSINK ASSY ---Attaching Parts		1
3	201330-602	. SCREW, 8-32 X .375L, Flat Head		1
4	800859-01	. WASHER, Nylon, #8 X .400 OD/.068T		1
5	90-03024	. KEPNUT, 8-32 X .343W ---*---		2
6	801505-08	. PCB ASSY, Charger		1
7	801504-05	. . CHARGER PCB		1
C1	200100-100	. . CAPACITOR, Electrolytic, 500µf/250V		1
8	800858-01	. . INSULATOR ---Attaching Parts		1
9	201113-134	. . SCREW, 10-32 X .275, Binder Head		2
10	90-04019	. . WASHER, Flat, #10		2
11	90-04067	. . WASHER, Flat, Nylon #10		2
12	90-03023	. . KEPNUT, 10-32 ---*---		2
C2	200322-061	. . CAPACITOR, 100µf/50V		1
C3	200507-030	. . CAPACITOR, Disk, .01µf/1KV		1
C4	200362-026	. . CAPACITOR, .15µf/100V		1
C5	200090-006	. . CAPACITOR, Tantalum, 330µf/3V		1
C6	200322-004	. . CAPACITOR, Electrolytic, 270µf/25V		1
C7	200356-031	. . CAPACITOR, Tantalum, 2.2µf/35V		1
C9	200264-020	. . CAPACITOR, .22µf/50V		1
C11	200205-036	. . CAPACITOR, Electrolytic, 22µf/35V		1
C13	200264-018	. . CAPACITOR, .1µf/50V		1
C14	200356-031	. . CAPACITOR, Tantalum, 2.2µf/35V		1
CR1,2	200658-002	. . DIODE, MR812, 200NS, PIV200		2
CR3	200605-009	. . DIODE, Zener, IN4737A		1
CR4	200658-002	. . DIODE, MR812, 200NS, PIV200		1
CR5	200498-002	. . DIODE, VSK3040T		1
13	90-09106	. . SILPAD		1
14	801426-02	. . HEATSINK ---Attaching Parts		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-22B				
25	200475-262	. . SCREW, 4-40 X .375L, Binder Head		2
16	90-04004	. . WASHER, Fiber, #4 X .250 OD,.062T		2
17	90-03019	. . KEPNUT, 4-40 ---*---		2
CR6	201255-005	. . DIODE, Schottky, SSH1A080		1
CR7	200284-005	. . DIODE, IN4005		1
CR8	200499-026	. . DIODE, FWL600 Bridge Rectifier		1
CR9	200284-005	. . DIODE, IN4005		1
F6	201167-008	. . FUSE, Mini, 2A/125V		1
F7,8	201167-015	. . FUSE, Mini, 10A/32V		2
K1	201326-000	. . RELAY, 10A, 6VDC		1
L1	800210-00	. . INDUCTOR, RFI Suppressor		1
18	200624-004	. . TUBING, Teflon, .027 ID, Thin wall ---Attaching Parts		A/R
19	NO NUMBER	. . SCREW, 10-32 X 1.000L		1
20	NO NUMBER	. . NUT, Cad-plated, 10-32 ---*---		1
L2	800328-00	. . INDUCTOR, Filter Choke		1
Q1,2	201343-001	. . TRANSISTOR, MFI2003		2
21	801425-01	. . HEATSINK		1
22	90-09106	. . SILPAD		2
23	201321-000	. . INSULATOR, Berylium Oxide ---Attaching Parts		2
24	200476-233	. . SCREW, 2-56 X .563L, Pan Head		2
25	200476-232	. . SCREW, 2-56 X .500L, Pan Head		2
26	200144-667	. . WASHER, Flat, #6 X .250 OD/.062T		4
27	802056-00	. . SLEEVE, Insulating		4
28	90-04038	. . WASHER, Flat, #2 X .250 OD/.015T		4
29	90-03004	. . HEXNUT, 2-56 ---*---		4
Q3	200942-001	. . TRANSISTOR, PN2222A		1
Q6	200888-003	. . TRANSISTOR, 2N2907A		1
R1	200471-111	. . RESISTOR, 43 K, 1/2W, 5%		1
R2	200270-066	. . RESISTOR, 56, 2W, 5%		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-22B				
R3	200270-015	. . RESISTOR, 43, 2W, 5%		1
R4	200470-068	. . RESISTOR, 680, 1/4W, 5%		1
R5	200578-046	. . RESISTOR, 8.2, 1W, 5%		1
R6	200471-026	. . RESISTOR, 12, 1/2W, 5%		1
R7	200578-105	. . RESISTOR, 2.4 K, 1W, 5%		1
R8	200471-030	. . RESISTOR, 18, 1/2W, 5%		1
R9	200470-080	. . RESISTOR, 2.2 K, 1/4W, 5%		1
R10	200470-072	. . RESISTOR, 1 K, 1/2W, 5%		1
R13	200471-000	. . RESISTOR, 1, 1/2W, 5%		1
R14	200470-086	. . RESISTOR, 3.9 K, 1/4W, 5%		1
R15	200471-120	. . RESISTOR, 100 K, 1/2W, 5%		1
R16	200470-096	. . RESISTOR, 10 K, 1/4W, 5%		1
30	90-09089	. . INSULATOR, Cradle Mount (Used on R2, R3, R5, R)		4
RT1	200486-004	. . THERMISTOR		1
T1	801330-01	. . TRANSFORMER, 117V		1
T2	800329-01	. . TRANSFORMER, Feedback		1
U1,3	200414-000	. . VOLTAGE REGULATOR, LM317		2
31	90-09106	. . SILPAD		2
32	201325-001	. . HEATSINK ---Attaching Parts		1
33	201112-036	. . SCREW, 4-40 X .250L, Pan Head		2
34	90-03019	. . KEPNUT, 4-40 X .250W		2
35	200358-110	. . WIRE, Stranded, #22, CSA, Red		A/R
36	200358-109	. . WIRE, Stranded, #22, CSA, Black		A/R
37	200276-209	. . TERMINAL LUG ---Attaching Parts		2
38	90-04018	. . WASHER, Lock, #10 X .500 OD/.049T ---*---		2
39		. . WIRE, Stranded, #18, CSA, Red		A/R

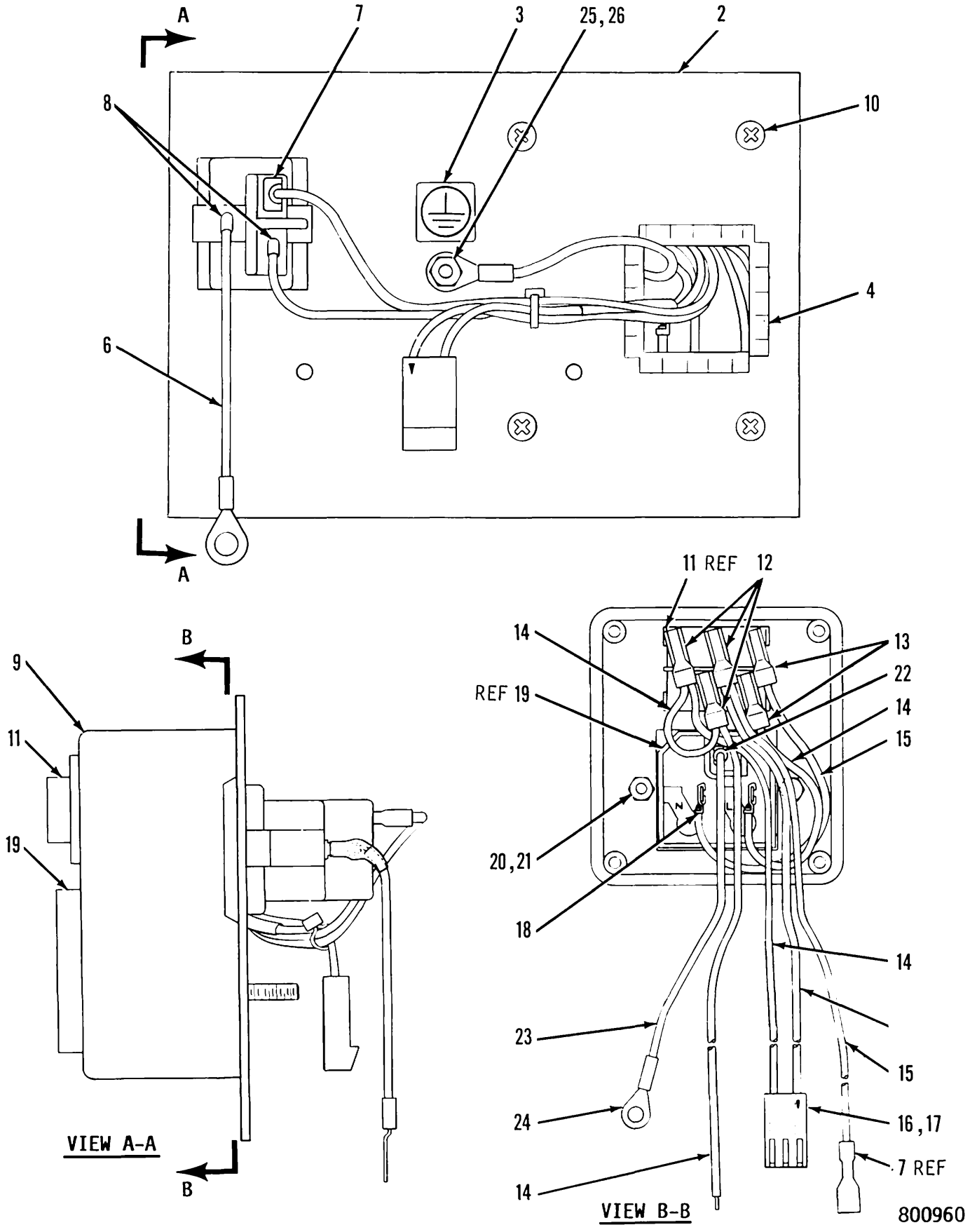


FIGURE 5-23A. HEATSINK ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-23A				
1	800960-00	HEATSINK ASSY (Appliance Connector)		REF
2	800199-09	. HEATSINK PLATE		1
3	800943-02	. . LABEL, Earth Ground		1
4	90-10010	. . GROMMET, Continuous		A/R
5	200600-000	. RECEPTACLE, Snap-In		1
6	200358-272	. . WIRE, Stranded, #18, CSA, GRN/YEL		A/R
7	200267-002	. . TERMINAL, Tab, .110W X .020T		1
8	200283-004	. . TUBING, Heat Shrink, .187 ID, Red		A/R
9	800936-00	. HOUSING ASSY ---Attaching Parts		1
10	200497-014	. SCREW, 6-32 X .375L ---*---		4
11	800989-00	. . SWITCH, Rocker		1
12	200514-001	. . . TERMINAL, Quick-Disconnect		3
13	200514-000	. . . TERMINAL, Quick-Disconnect		2
14	200358-060	. . . WIRE, Stranded, #18, CSA, Brown		A/R
15	200358-059	. . . WIRE, Stranded, #18, CSA, Blue		A/R
16	200277-001	. . . CONNECTOR HOUSING		1
17	200390-016	. . . SOCKET, Crimp		2
18	200598-000	. . . TERMINAL, Flag		2
19	200602-000	. . FUSEHOLDER, Dual ---Attaching Parts		1
20	201105-539	. . SCREW, 4-40 X .437L, Flat Head		2
21	90-03019	. . HEXNUT, 4-40 ---*---		2
22	200916-000	. . . TERMINAL, Slip-On		1
23	200358-272	. . . WIRE, Stranded, #18, CA, GRN/YEL		A/R
24	90-06069	. . . TERMINAL, #6, Red ---Attaching Parts		1
25	201105-570	. . . SCREW, 6-32 X .375L, Flat Head		1
26	90-03021	. . . HEXNUT, 6-32 ---*---		1

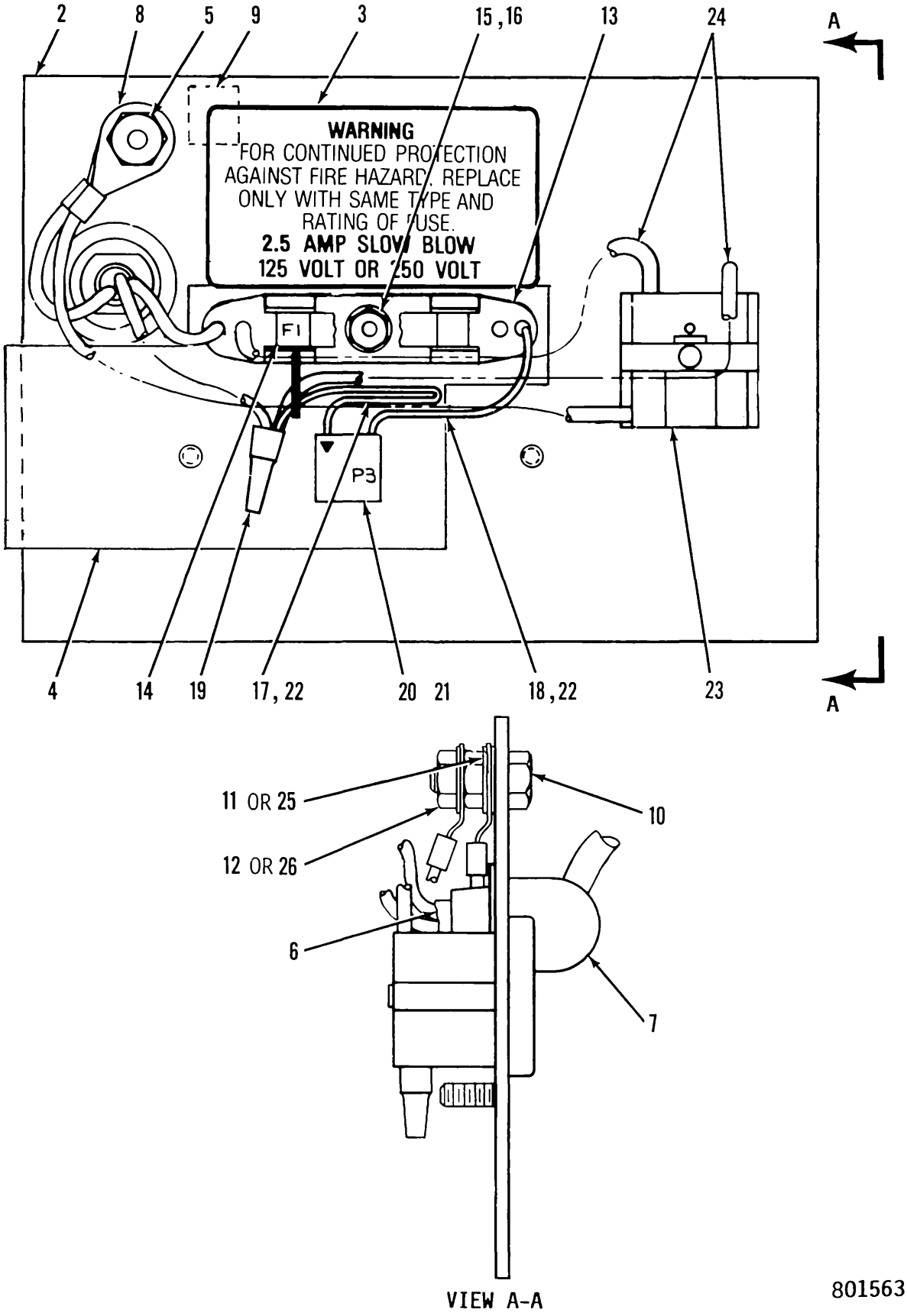


FIGURE 5-23B. HEATSINK ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-23B				
1	801563-00	HEATSINK ASSY	A	REF
	801563-01	HEATSINK ASSY	B	
2	800199-11	. HEATSINK PLATE	A	1
	800199-18	. HEATSINK PLATE	B	1
3	801362-00	. . LABEL, Fuse Warning		1
4	800670-02	. . SILPAD		1
5	800943-02	. . LABEL, Earth Ground		1
6	800445-05	. POWER CORD ASSY	A	1
	800445-09	. POWER CORD ASSY	B	1
7	200150-001	. STRAIN RELIEF, .625 Hole		1
8	90-06043	. TERMINAL, Ring	A	1
	200276-212	. TERMINAL, Ring ---Attaching Parts	B	1
9	801946-00	. WASHER, Strain Relief ---*---		1
10	201185-000	. CONNECTOR, Banana Jack ---Attaching Parts		1
11	90-04027	. LOCKWASHER, 1/4 X .450 OD/.020T		2
12	201226-057	. HEXNUT, 1/4-32 X .437W ---*---		1
13	2-22054-00	. FUSEHOLDER		1
14	200256-118	. FUSE, Slow, 2.5A/125V (F1) ---Attaching Parts		1
15	90-01062	. SCREW, 6-32 X .375L, Flat Head	A	1
	201105-570	. SCREW, 6-32 X .375L, Pan Head	B	1
16	90-03021	. HEXNUT, 6-32 X .250W/.098T ---*---		1
17	200357-108	. WIRE, Stranded, #22, CSA, White		A/R
18	200357-109	. WIRE, Stranded, #22, CSA, Black		A/R
19	200992-000	. TERMINAL, End Splice		1
20	200277-001	. CONNECTOR HOUSING (P3)		1
21	2-20241-00	. TERMINAL SOCKET	A	2
	200390-016	. TERMINAL SOCKET, Crimp	B	2
22	09-07025	. TUBING, Clear, #12		A/R
23	200996-000	. CONNECTOR, Snap-In, AC		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-23B				
24	90-07021	. TUBING, Clear, #6	B	A/R
25	90-04017	. LOCKWASHER, #8		1
26	90-03024	. KEPNUT, 8-32 X 11/32		2

LEFT BLANK INTENTIONALLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-24				
1	801820-01	PCB ASSY, Main Defib		REF
2	801819-02	. BOARD, Printed Circuit		1
C1	200322-049	. CAPACITOR, Electrolytic, 560µf/20V		1
		---Attaching Parts		
3	201112-092	. SCREW, 6-32 X 1.750, Pan Head		1
4	90-03018	. HEXNUT, 6-32		1
		---*---		
C2	200026-000	. CAPACITOR, .01µf/8KV, 10%		1
C3,4	200901-163	. CAPACITOR, 5600pf/50V, 10%		3
C5	200495-107	. CAPACITOR, 2200pf/125V, 2.5%		1
C6,7	200893-034	. CAPACITOR, .1µf/50V, 10%		12
C8	2-12654-00	. CAPACITOR, Electrolytic, 100µf/25V		2
C9-16		. (Same As C6)		
C17		. (Same As C8)		
C18	200893-022	. CAPACITOR, .01µf/50V, 10%		1
C19	200205-046	. CAPACITOR, Electrolytic 2.2µf/50V, 10%		1
C20	200205-045	. CAPACITOR, Electrolytic, 1µf/50V, 10%		1
C21	200893-042	. CAPACITOR, .47µf/50V, 10%		2
C22	200205-025	. CAPACITOR, 22µf/25V, 10%		1
C23,24		. (Same As C6)		
C25		. (Same As C3)		
C29	200893-014	. CAPACITOR, 2200pf/50V, 10%		1
C30	200274-008	. CAPACITOR, 18pf/500V, 10%		1
C31		. (Same As C21)		
CR1	200881-000	. DIODE, SFES20K		1
5	200283-007	. TUBING, Heat Shrink, .500 ID, Red		A/R
		---Attaching Parts		
6	201112-044	. SCREW, 4-40 X .750, Pan Head		1
7	201118-757	. SPACER, 4-40		1
8	200703-000	. TERMINAL, Standoff		1
		---*---		
CR2	200177-019	. DIODE, Zener, P6KE16A		1
CR7	2-14000-00	. DIODE, IN270		10
CR10	200083-002	. DIODE, IN5819		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-24				
CR13	200034-000	. DIODE, IN746A		1
CR14	200233-152	. DIODE, IN5373B		1
CR15	200284-005	. DIODE, IN4005		2
CR16	200103-009	. DIODE, Zener, MPTE-5		1
CR17	200085-019	. DIODE, Zener, IN4104		1
CR20-27		. (Same As CR7)		
CR31		. (Same As CR15)		
CR32		. (Same As CR7)		
DS4	200057-000	. LED, Red, 2.1VDC, 15mA		1
F1	200281-037	. FUSE, 15A/32V		1
F2	200281-019	. FUSE, 1.25A/250V		1
F3	200256-118	. FUSE, 2.50A/125V		1
9	201345-001	. FUSEHOLDER		6
J1	200279-000	. IC SOCKET		1
J2,3	200096-006	. CONNECTOR		2
J4	201339-000	. SOCKET		1
J5	2-20171-00	. TERMINAL, Quick Disconnect		1
J6	200096-000	. CONNECTOR		1
J7	200096-002	. CONNECTOR		1
J8	200663-000	. CONNECTOR, 90 degree		1
J9	200534-028	. CONNECTOR		1
J10	200397-003	. CONNECTOR		1
L1	200833-013	. INDUCTOR, 500µH, 500mA		1
L2	2-35456-00	. INDUCTOR, Ferrite Band		1
10	90-09089	. INSULATOR, Mount (Used with L1, L2)		2
Q1,2	201197-000	. TRANSISTOR, D44VH ---Attaching Parts		2
11	200475-262	. SCREW, 4-40 X .375L, Binder Head		2
12	90-03019	. HEXNUT, 4-40 ---*---		2
Q3,4	201221-000	. TRANSISTOR, MPS6651		2
Q5,6	200387-001	. TRANSISTOR, MPSA14		11

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-24				
Q7	200942-001	. TRANSISTOR, PN222A		4
Q8,9	200888-001	. TRANSISTOR, PN2907A		5
Q10-18		. (Same As Q5)		
Q19-21		. (Same As Q8)		
Q22,23	2-14608-00	. TRANSISTOR, MJE-223 ---Attaching Parts		2
13	200475-262	. SCREW, 4-40 X .375L, Binder Head		2
14	90-03019	. HEXNUT, 4-40 ---*---		2
Q24	201236-000	. TRANSISTOR, 2N6274		1
15	801883-00	. HEATSINK		1
16	801857-00	. BRACKET		1
17	2-35189-00	. GROMMET, Continuous ---Attaching Parts		A/R
18	200475-296	. SCREW, 6-32 X .500L, Binder Head		2
19	200431-553	. WASHER, Shoulder, #6 X .328 OD/.060T		2
20	90-03021	. KEPNUT, 6-32 ---*---		2
Q25-27		. (Same As Q7)		
Q28	200429-000	. TRANSISTOR, 2N5116		1
R1,2	801884-000	. RESISTOR, 64 M, 1W, 1%		2
R3,4	201155-001	. RESISTOR, 50 M, 1W, 5%		2
R5	200054-384	. RESISTOR, 100 K, 1/8W, 1%		9
R6	200054-344	. RESISTOR, 38.3 K, 1/8W, 1%		1
R7-9	200839-193	. RESISTOR, 1 K, 1/4W, 1%		4
R10	200054-305	. RESISTOR, 15 K, 1/8W, 1%		8
R11	200054-204	. RESISTOR, 1.3 K, 1/8W, 1%		3
R12	200054-173	. RESISTOR, 620, 1/8W, 1%		5
R13	200054-330	. RESISTOR, 27.4 K, 1/8W, 1%		4
R14	200054-451	. RESISTOR, 499 K, 1/8W, 1%		1
R15		. (Same As R13)		
R16	200054-356	. RESISTOR, 51.1 K, 1/8W, 1%		2
R17		. (Same As R10)		

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-24				
R18	200850-069	. RESISTOR, 51, 1/2W, 1%		2
R19	200850-173	. RESISTOR, 620, 1/2W, 5%		2
R20	200054-122	. RESISTOR, 182, 1/8W, 1%		5
R21		. (Same As R18)		
R22	200270-028	. RESISTOR, 1.5, 2W, 5%		1
R23		. (Same As R12)		
R24	201166-006	. RESISTOR, 1 K, 1/2W, 10%		3
R25		. (Same As R12)		
R26	200054-249	. RESISTOR, 3.92K, 1/8W, 1%		5
R27	200054-154	. RESISTOR, 392, 1/8W, 1%		1
R28		. (Same As R7)		
R29	200054-058	. RESISTOR, 39.2, 1/8W, 1%		2
R30		. (Same As R13)		
R31		. (Same As R5)		
R32,33	200270-078	. RESISTOR, 180, 2W, 5%		2
R34		. (Same As R29)		
R35,36		. (Same As R5)		
R37,38	200270-054	. RESISTOR, 18, 2W, 5%		2
R39-41		. (Same As R20)		
R42		. (Same As R26)		
R43	200054-378	. RESISTOR, 86.6 K, 1/8W, 1%		1
R44		. (Same As R26)		
R45		. (Same As R19)		
R46,47		. (Same As R10)		
R48,49		. (Same As R11)		
R50	200054-097	. RESISTOR, 100, 1/8W, 1%		1
R51		. (Same As R10)		
R52		. (Same As R5)		
R53		. (Same As R10)		
R54		. (Same As R12)		
R55		. (Same As R10)		
R56		. (Same As R13)		
R57		. (Same As R24)		

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-24				
R58,59		. (Same As R26)		
R60		. (Same As R24)		
R61,62	200504-012	. RESISTOR, 50 K, 1/2W, 20%		2
R63	200504-008	. RESISTOR, 5 K, 1/2W, 20%		1
R64		. (Same As R5)		
R65		. (Same As R10)		
R66		. (Same As R12)		
R67		. (Same As R20)		
R68-70	200054-081	. RESISTOR, 68.1, 1/8W, 1%		3
R71		. (Same As R5)		
R72		. (Same As R16)		
R73		. (Same As R5)		
R74	200054-284	. RESISTOR, 9.09 K, 1/8W, 1%		1
R75	200054-292	. RESISTOR, 11 K, 1/8W, 1%		1
R76		. (Same As R5)		
R77	200470-144	. RESISTOR, 1 M, 1/4W, 5%		1
21	90-09089	. INSULATOR MOUNT (Used with R22, R32, R33, R37, R38)		5
RN1	200422-038	. RESNET, 7 X 10 K, 1.1W, 2%		1
RN2-4	201240-024	. RESNET, 3 X 3.9 K, .8W, 5%		4
RN5	201240-018	. RESNET, 3 X 100 K, .8W, 5%		1
RN6		. (Same As RN2)		
RV1,2	201251-002	. VARISTOR, 18V		2
T1	800411-02	. TRANSFORMER, Flyback ---Attaching Parts		1
22	200475-293	. SCREW, 6-32 X .312L, Binder Head		2
23	90-04014	. LOCKWASHER, #6 X .385 OD/.020T ---*---		2
U1	801760-201	. IC, 6805R2 ATTENTION		1
U2	200056-000	. IC, UA759UIC ---Attaching Parts		1
24	200475-262	. SCREW, 4-40 X .375L, Binder Head		1
25	200431-692	. SHOULDER WASHER, #4 X .250 OD/.081T		1
26	90-03019	. HEXNUT, 4-40 ---*---		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-24				
U3	200359-002	. IC, 1403/3503 ATTENTION		1
U4	200359-003	. IC, MC1404U ATTENTION		1
U5	200669-002	. IC, LM339N		1
U6,7	2-14410-00	. IC, LM324N		2
U8	2-14359-00	. IC, NE555 ATTENTION		1
U9	201242-000	. IC, CD4047		1
27	200675-009	. Socket (Used with U1)		1
28	200033-002	. Socket (Used with U3, U4)		2
VSP1	200324-008	. VSP, 6.4 KVdc, 1pf		1
VSP2,3	200324-001	. VSP, 90Vdc, 1pf		2
Y1	200417-004	. CRYSTAL 4.0 MHZ		1
29	90-09138	. WIRE, Bus, AWG #22		A/R
30	200405-020	. CABLE, Stranded, #22		A/R

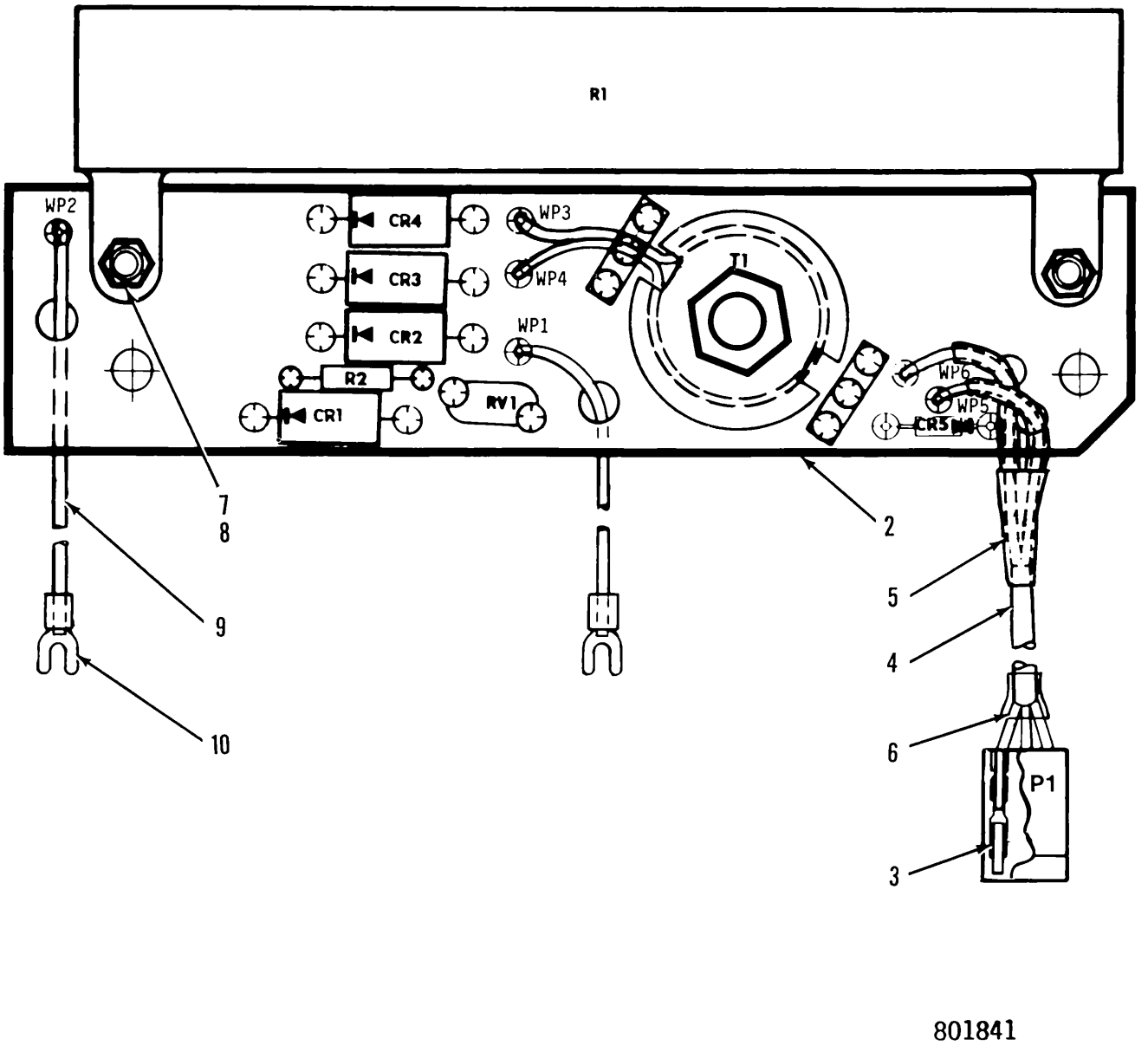


FIGURE 5-25. TEST LOAD PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-25				
1	801841-00	PCB ASSY, Test Load		REF
2	801840-01	. BOARD, Printed Circuit		1
CR1-4	201273-001	. DIODE, IN5401		4
CR5	200284-005	. DIODE, IN4005		1
P1	200419-020	. CONNECTOR, 3-contact		1
3	200390-000	. SOCKET		3
4	200404-042	. CABLE, Shielded, #22, CSA		1
5	200283-005	. TUBING, Heat Shrink, .250 ID, Red		A/R
6	200624-013	. TUBING, Teflon, Thin Wall, .085 ID		A/R
R1	200783-000	. RESISTOR, 50 Ohm, 50W, 5% ---Attaching Parts		1
7	200475-292	. SCREW, 6-32 X .250L, Binder Head		2
8	90-03021	. HEXNUT, 6-32 ---*---		2
R2	200054-068	. RESISTOR, 49.9 Ohm, 1/8W, 1%		1
RV1	201251-000	. VARISTOR, V18ZA1		1
T1	801853-00	. TRANSFORMER TEST LOAD		1
9	200405-020	. CABLE, Unshielded, #22		A/R
10	200671-034	. TERMINAL, Spade Lug		2

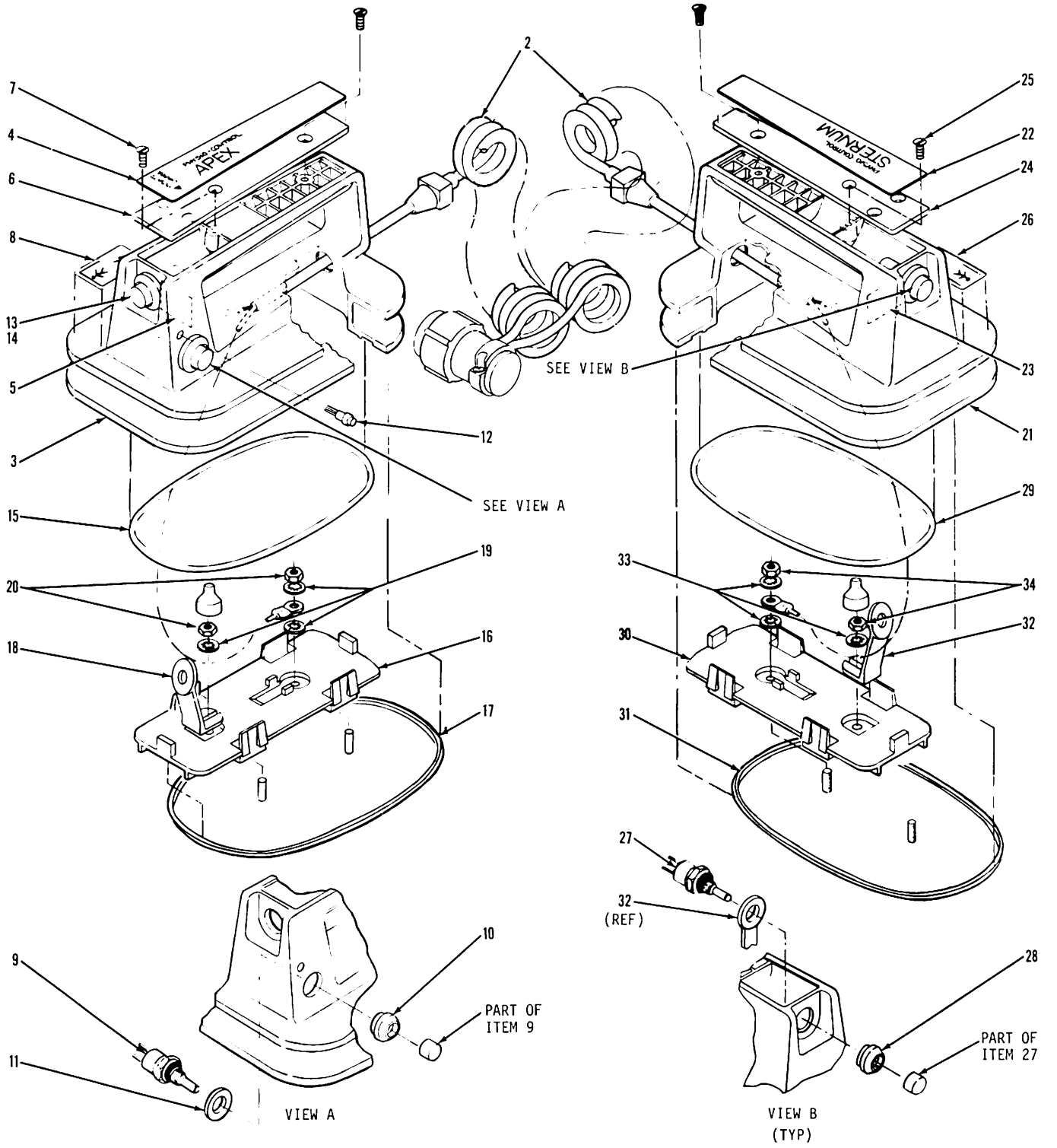


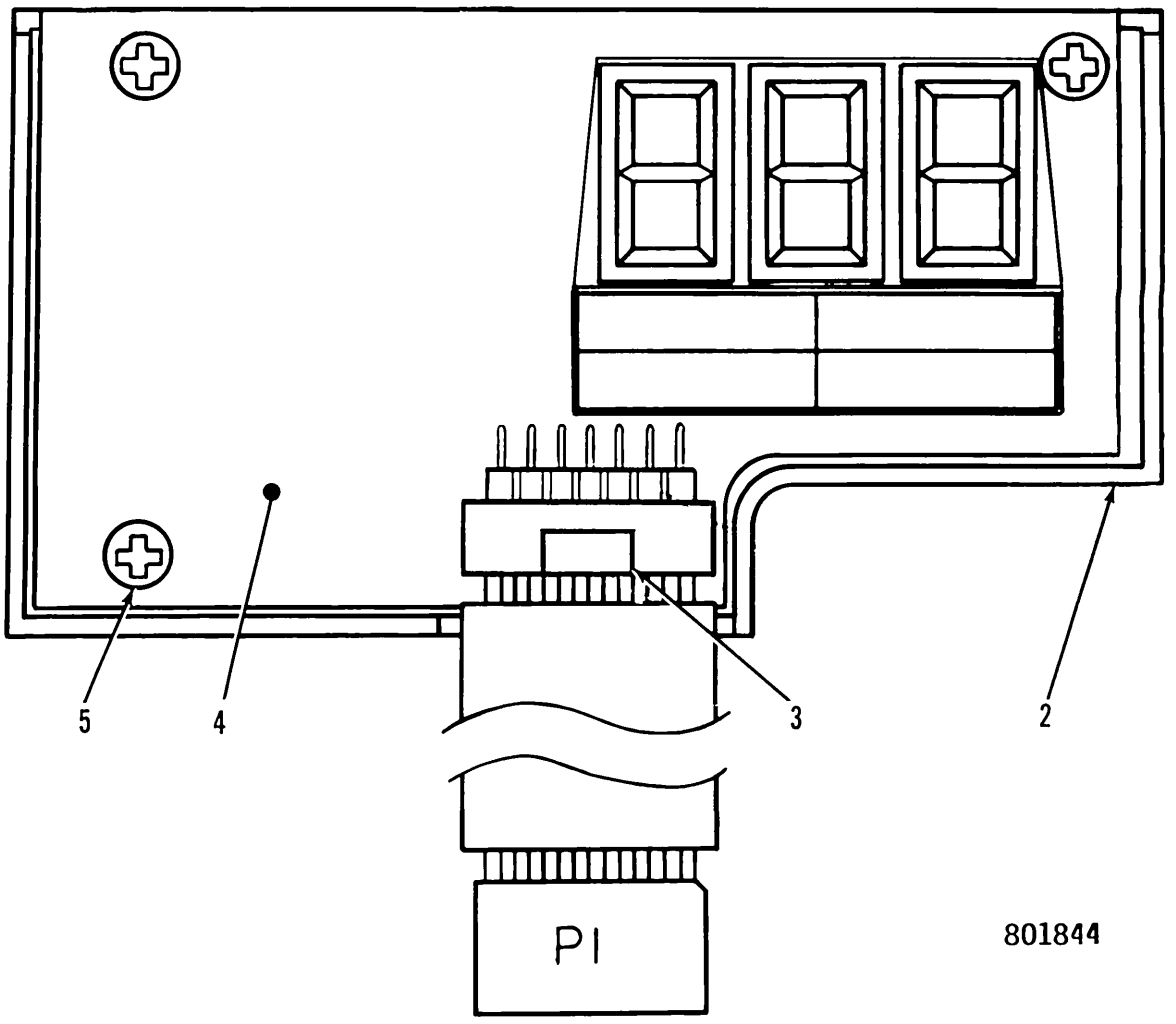
FIGURE 5-26. PADDLES ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-26				
1	800250-09	PADDLES ASSY	A	REF
	800250-10	PADDLES ASSY	B	
2	800251-02	. COIL CORD ASSY		1
3	800254-05	. APEX PADDLE		1
4	801979-00	. . LABEL, Apex Paddle	A,B	1
5	800819-00	. . LABEL, Serial Number		1
6	801030-01	. . HANDLE COVER ---Attaching Parts		1
7	200320-006	. . SCREW, 4-20 X .312L, Flat Head ---*---		2
8	800943-01	. . LABEL, High Voltage	B	1
9	200899-002	. . PUSHBUTTON SWITCH, 115VAC, Amber		1
10	801022-00	. . BEZEL		1
11	801022-01	. . WASHER		1
12	200059-002	. . LED, 1.6Vdc, 20mA, Amber		1
13	200899-001	. . PUSHBUTTON SWITCH, 115VAC, Black		1
14	801022-00	. . BEZEL		1
15	200060-003	. . O-RING, 3.737 ID		
16	800255-01	. . RETAINER PLATE, Electrode		1
17	1-41429-02	. . ELECTRODE PLATE		1
18	801855-00	. . ELECTRODE PLATE STRAP ---Attaching Parts		1
19	90-04057	. . LOCKWASHER, #8 X .330 OD/.020T		3
20	90-03042	. . HEXNUT, 8-32 ---*---		2
21	800254-04	. STERNUM PADDLE		1
22	801980-00	. . LABEL, Sternum Paddle	A,B	1
23	800819-00	. . LABEL, Serial Number		1
24	801030-01	. . HANDLE, Cover ---Attaching Parts		1
25	200320-006	. . SCREW, 4-20 X .312L, Flat Head ---*---		2
26	800943-01	. . LABEL, High Voltage	B	1
27	200899-001	. . PUSHBUTTON SWITCH, 115 VAC, Black		1

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-26				
28	801022-00	. . BEZEL		1
29	200060-003	. . O-RING, 3.737 ID		1
30	800255-01	. . RETAINER PLATE, Electrode		1
31	1-41429-02	. . ELECTRODE PLATE		1
32	801855-00	. . ELECTRODE PLATE STRAP ---Attaching Parts		1
33	90-04057	. . LOCKWASHER, #8 X .330 OD/.020T		3
34	90-03042	. . HEXNUT, 8-32 ---*---		2



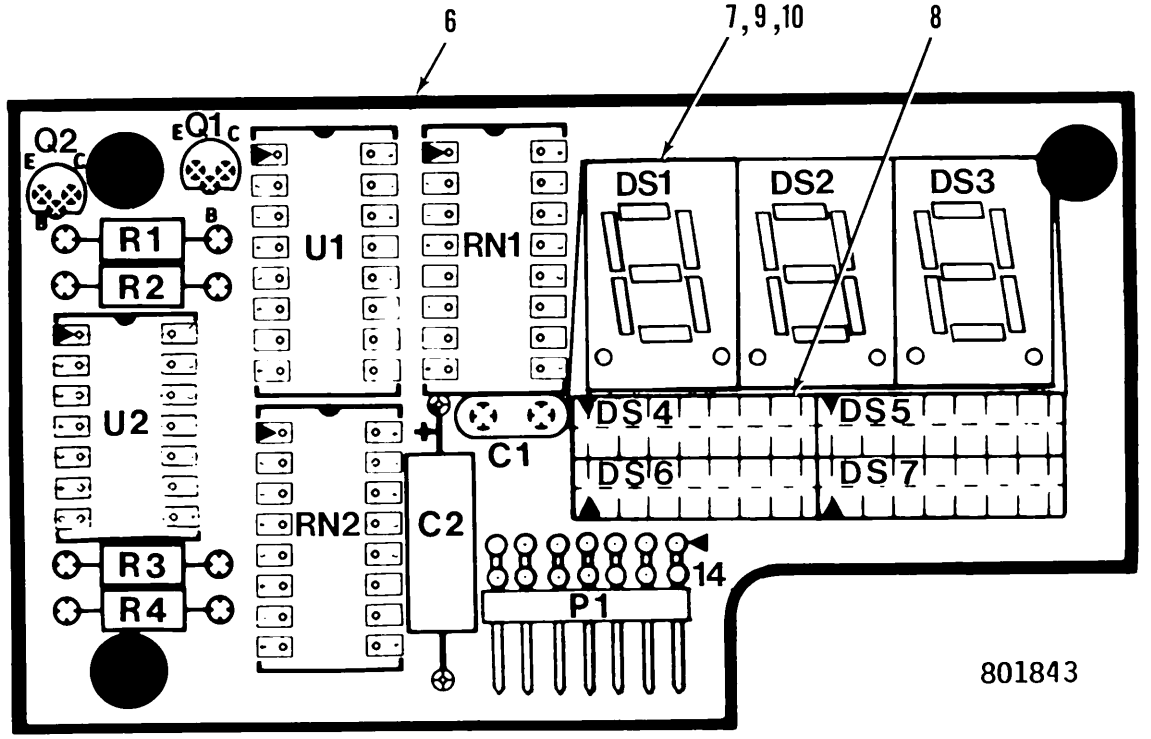


FIGURE 5-27. ENERGY METER PCB ASSEMBLY

PARTS LIST

FIG-ITEM	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	USE CODE	QTY
5-27				
1	801844-01	ENERGY METER ASSY		REF
2	801845-01	. BRACKET, Energy Meter		1
3	801846-01	. JUMPER CABLE		1
4	801843-01	. ENERGY METER PCB ASSY ---Attaching Parts		1
5	200531-001	. SCREW, 4-24 X .250L, Pan Head ---*---		3
6	801842-01	. . ENERGY METER PCB		1
C1	200893-034	. . CAPACITOR, .1µf/50V		1
C2	200204-010	. . CAPACITOR, 22µf/16V		1
DS1-3	801957-01	. . LED DISPLAY, 7-segment		3
DS4-7	201235-003	. . LED DISPLAY, Light Bar		4
7	200907-001	. . SOCKET, IC (Used with DS1,2,3)		3
8	201259-014	. . RECEPTACLE (Used with DS4,5,6,7)		4
P1	201338-002	. . CONNECTOR		1
Q1,2	200888-001	. . TRANSISTOR, PN2907A		2
R1	200054-222	. . RESISTOR, 2 K, 1/8W, 1%		2
R2	2-00054-122	. . RESISTOR, 182, 1/8W, 1%		1
R3,4		. . (Same As R1)		
RN1	200043-019	. . RESNET, 8 X 130, 1½W, 2%		1
RN2		. . RESNET, 8 X 470, 1½W, 2%		1
U1	200111-000	. . IC, MM74C48		1
U2	200183-000	. . IC, 4081B		1
9	200712-000	. . TAPE, Polyester		A/R
10	802072-00	. . SPACER		2

LIFEPAK® 6s defibrillator/monitor

OPERATING INSTRUCTIONS

PHYSIO CONTROL

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CAUTIONS

- Federal (USA) law restricts this device to sale by or on the order of a physician.
- This instrument is to be used by authorized personnel only.
- The operator should be thoroughly familiar with the information in this manual before using instrument.
- The LIFEPAK 6s defibrillator/monitor should not be used in the presence of flammable agents or anesthetics.
- Do not discharge defibrillator with paddles shorted together.
- Stay clear of patient when defibrillating. Contact with patient presents a potential shock hazard during defibrillation.
- Keep defibrillator paddles clean. Paddle handles covered with gel (wet or dry) present a hazardous electrical pathway between the paddle electrodes and the user during defibrillator discharge.
- For patient safety, do not connect accessory equipment to the "ECG OUTPUT" jack unless accessory equipment in combination with LIFEPAK 6s system has been evaluated for fire and shock hazard.
- Do not discharge defibrillator into open air. Rotate energy select switch or turn defibrillator off to dump unwanted charge.

The Physio-Control LIFEPAK® 6s cardioscope, recorder, and DC defibrillator is a portable, compact unit with extreme versatility. It combines the capacity for emergency and long-term ECG monitoring with the capability of diagnostic tracings.

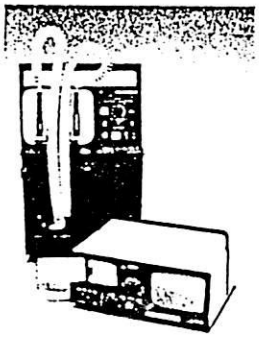
The LIFEPAK 6s consists of two modules: (1) an ECG monitor module with a cardioscope, recorder, and digital rate meter with alarms; and (2) a defibrillator module with synchronizer. When separated, the modules operate completely independently, each having its own internal battery and/or AC line operation capability. When joined, the two modules operate as one.

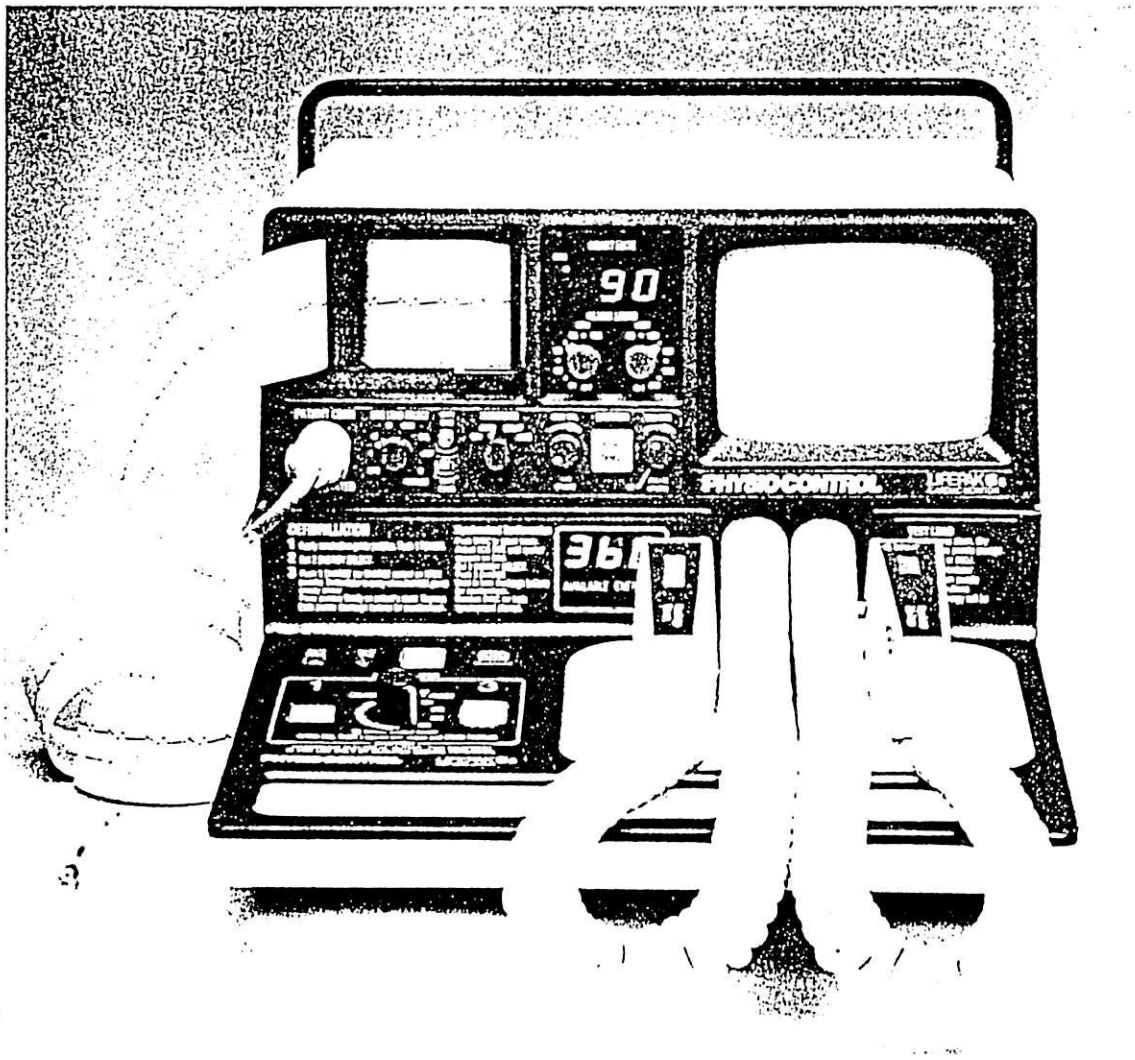
The combined unit is a very versatile cardiac care system which is designed for use in the hospital or clinic. In the emergency department or on a crash cart, QUIK-LOOK® paddles can be used immediately to pick up the patient's ECG for rapid patient assessment. The non-fade trace on the cardioscope can be frozen for inspection or the ECG may be recorded on standard ECG paper.

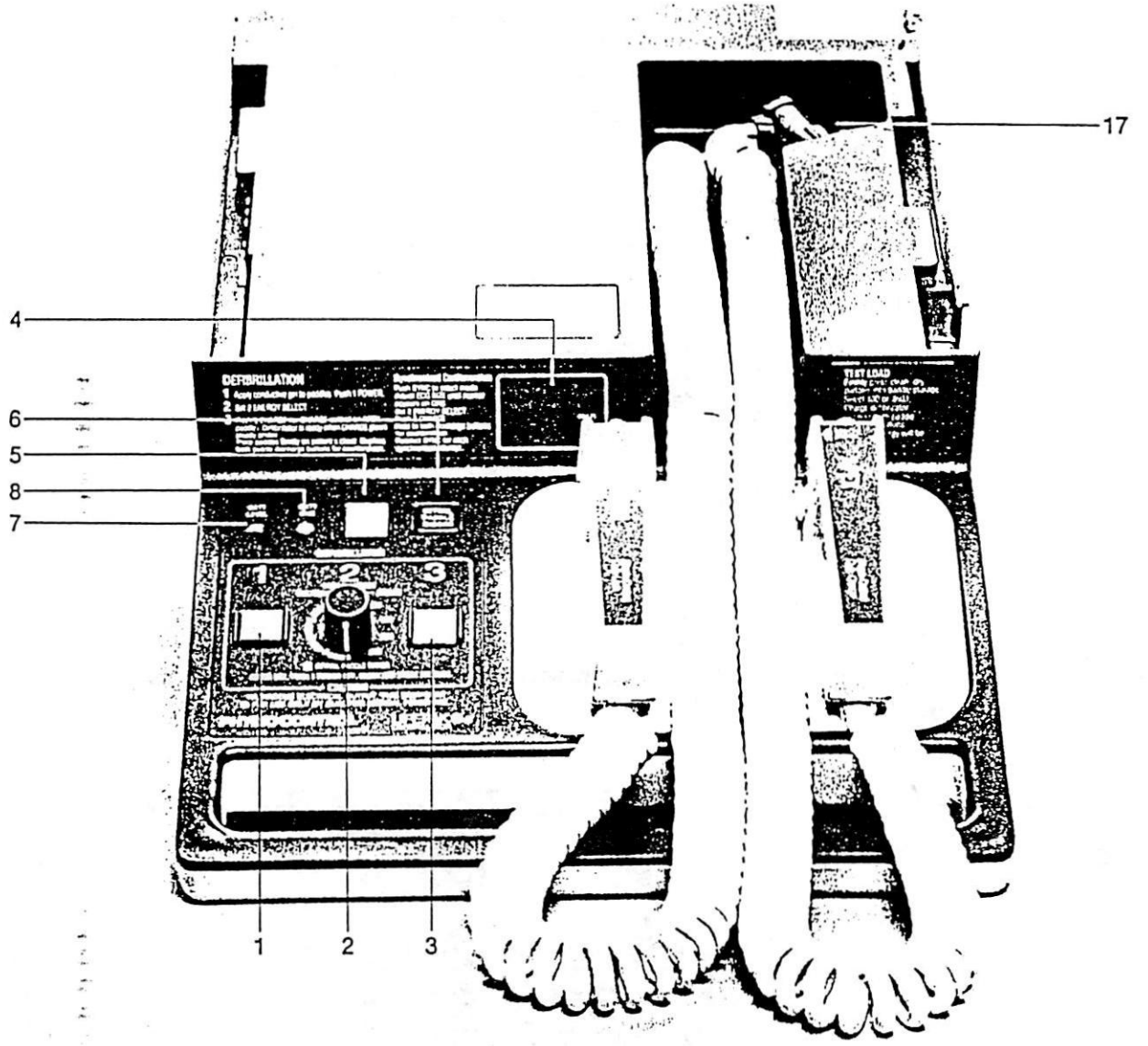
The use of the "DELAY" mode on the recorder will allow documentation of observed abnormalities. If defibrillation is necessary, a simple 1-2-3 procedure activates the defibrillator. The defibrillator may be charged by a switch on the module itself or by the QUIK-CHARGE® button on the "APEX" paddle.

After an initial emergency response, the LIFEPAK 6s monitor continues to serve as a long-term ECG monitor. It utilizes a low noise, fully shielded patient cable. An adjustable QRS beeper combined with the rate display, alarm limits, and automatic recorder make this a complete cardiac monitoring system.

The LIFEPAK 6s defibrillator/monitor may be used to perform elective cardioversion, diagnostic 12-lead ECGs and stress test monitoring. The "DIAG" recorder mode provides the broader frequency response necessary to obtain diagnostic tracings.







DEFIBRILLATOR

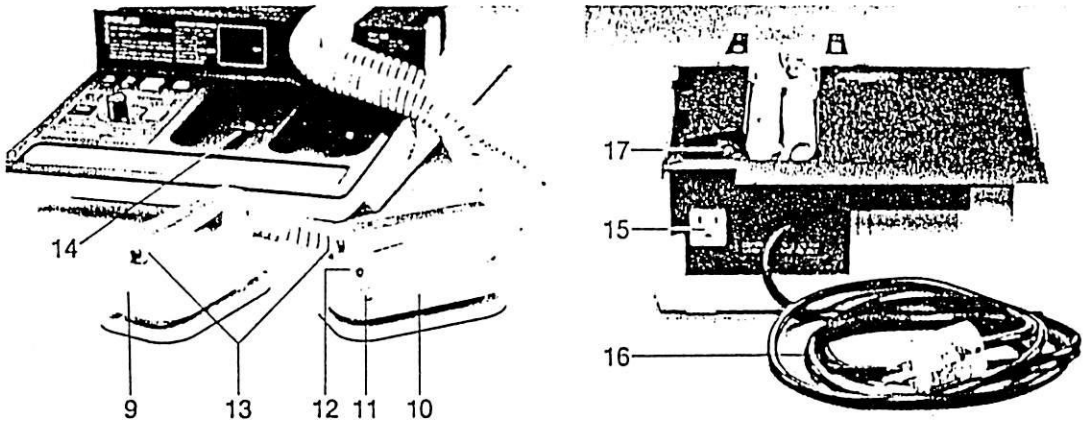
Front panel

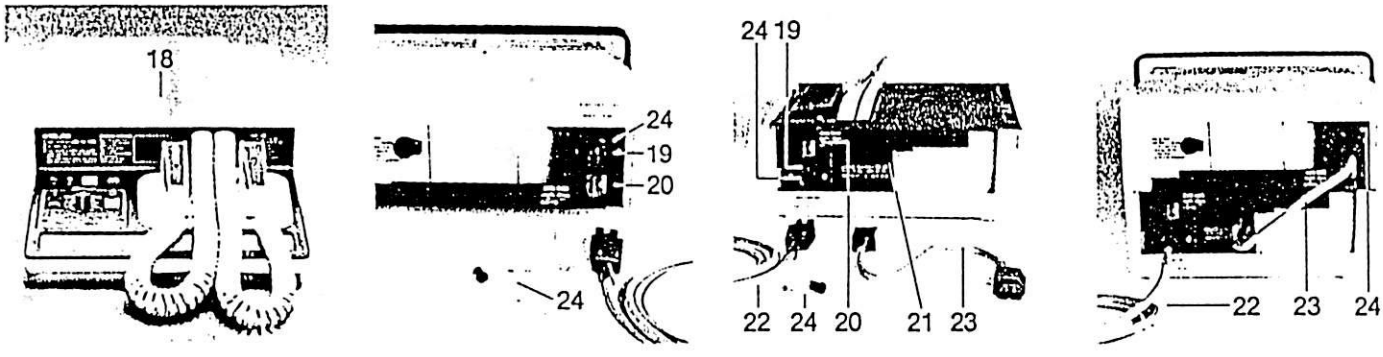
1.	POWER	Pushbutton control for power to defibrillator. Button lights when "POWER" is on.
2.	ENERGY SELECT	Rotary switch with 10 discrete energy levels; 5, 10, 20, 30, 50, 100, 150, 200, 300 and 360 joules.
3.	CHARGE	Momentary pushbutton to charge defibrillator to preselected level. Lighted pushbutton flashes while unit is charging, glows steadily when energy reaches preselected level. Energy is available for approximately 60 seconds. "CHARGE" light will extinguish when energy is no longer available for discharge. If "ENERGY SELECT" is changed after charge is initiated, charge will be "dumped" internally and recharge will be necessary.

4.	ENERGY DISPLAY WINDOW	Window for digital display of energy. Scrolling numbers indicate energy being charged. When charging complete, amount of energy available is displayed and "AVAILABLE ENERGY" message is backlit. Window also displays amount of energy delivered to test load when either 100J or 360J is discharged; "TEST LOAD" message backlit.
5.	SYNC	Momentary pushbutton switch to select synchronized mode. Button will light and blink off with each QRS. To return to defibrillate (asynchronous) mode, depress button again. Defibrillator must be connected to monitor for synchronized mode. **Note:** Defibrillator is automatically in defibrillate mode when turned on and automatically returns to defibrillate mode after each synchronous discharge.
6.	INTRNL PADDLE DISCHG	Momentary pushbutton to discharge defibrillator when internal paddles are used. Energy selections limited to 50J or less.
7.	BATT LEVEL	Meter indicates battery charge level. When marker is in green zone, battery is charged sufficiently to operate unit. When marker is in red zone, battery needs to be recharged. A depleted battery can be fully recharged in 16 hours by connecting power cord to grounded wall outlet.
8.	BATT CHG	Light indicates battery is being charged.

Paddles and storage area

9.	STERNUM PADDLE	Defibrillating electrode with one discharge pushbutton; usually placed to left of sternum (patient's right). Also serves as negative ECG electrode during QUIK-LOOK paddle monitoring.
10.	APEX PADDLE	Defibrillating electrode with charge control ("PUSH TO CHARGE") and second discharge pushbutton; usually placed near cardiac apex. Also serves as positive ECG electrode during QUIK-LOOK paddle monitoring.
11.	PUSH TO CHARGE (QUIK-CHARGE CONTROL)	Momentary pushbutton to charge defibrillator from "APEX" paddle.
12.	CHARGE INDICATOR	LED indicator flashes during charge cycle, glows steadily when energy has reached preselected level. **The defibrillator will not discharge while charge indicator is flashing.**
13.	DISCHARGE PUSHBUTTON	Pushbuttons to discharge defibrillator. Both buttons must be depressed **simultaneously** to deliver energy to the paddles. Energy will not be delivered unless the unit is fully charged to preselected level.
14.	TEST LOAD	50 ohm defibrillator test load. Metal contacts for receiving defibrillation pulse from paddles.





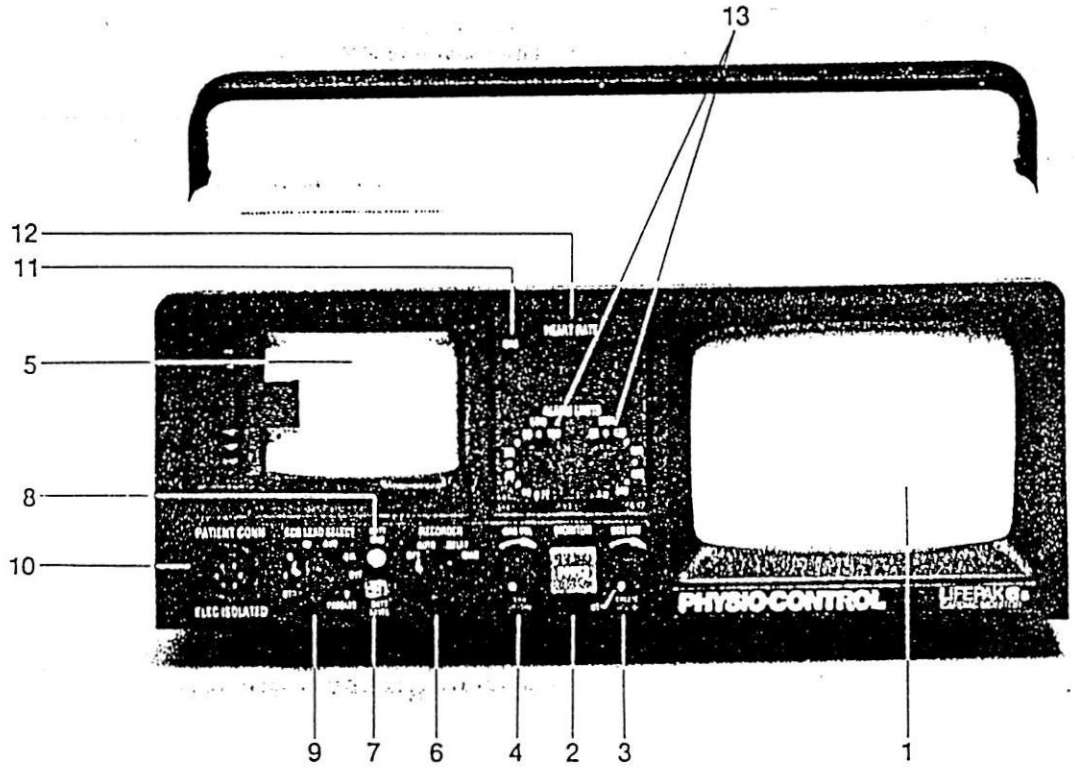
Back panel (115 VAC, 60 Hz model)

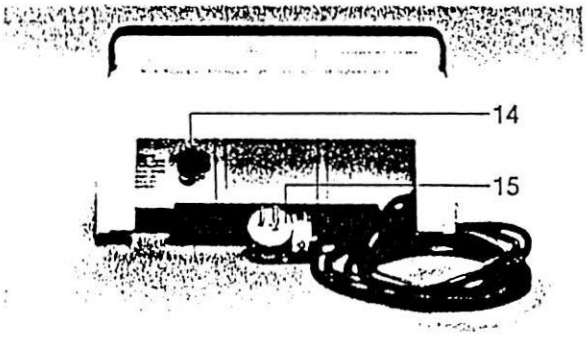
15.	POWER RECEPTACLE (for LIFEPAK 6s monitor)	Outlet for monitor power plug when both units are to be line-powered or charged from one power cord. Do not use this receptacle for any other equipment.
16.	POWER CORD	Connect to grounded AC line power outlet. Check that label on bottom panel matches available voltage/frequency.
17.	PADDLE CONNECT	Threaded connector for standard external, anterior/posterior or internal paddles. Connect and disconnect with fingers only.
18.	TOP COVER	Optional cover for stand-alone defibrillator.

220 and 240 VAC models

Note: Additional controls and indicators for 220 and 240 VAC models are restricted to the back panel.

19.	MAINS POWER INPUT	Connector for mains power cord.
20.	MAINS POWER ON-OFF	Rocker switch permits system to be energized by mains power.
21.	MAINS POWER OUTPUT RECEPTACLE	Receptacle for auxiliary power cord when both monitor and defibrillator are to be operated or charged from mains power.
22.	MAINS POWER CORD (for monitor or defibrillator)	Cable for mains power operation.
23.	AUXILIARY POWER CORD	Power cord to interconnect monitor and defibrillator when charge or operation is desired from a single mains power cord.
24.	MAINS FUSES	AC voltage/current overload protectors.





MONITOR

Cardioscope and recorder

1.	CARDIOSCOPE	Non-fade display. ECG trace moves from right to left.
2.	POWER	Pushbutton switch for main power to instrument. The "POWER" button on the LIFEPAK 6s monitor **does not** light when pushed on. Power to the monitor will be obvious from the appearance of a trace on the cardioscope.
3.	ECG SIZE	Knob controls vertical size of ECG trace on cardioscope and recorder. Turn clockwise to increase amplitude.
	X1	Full counterclockwise position standardizes ECG to a 10 mm high 1mV signal on recorder.
	FREEZE (PUSH)	Depress and hold knob to freeze trace on cardioscope. Release for current trace.

4.	QRS VOL	Knob controls volume of systole "beeper." Turn clockwise to increase volume.
	1mV (PUSH)	Depress and release knob to superimpose calibration signal on cardioscope and ECG write-out.
5.	RECORDER	Records ECG on standard ECG paper. To load paper, pull right side of recorder out.
6.	OFF/AUTO/DELAY/DIAG	4 position rotary switch selects "OFF" and three recorder "on" modes: "AUTO," "DELAY" and "DIAG." - "AUTO" records 15 seconds of ECG anytime set alarm limits are violated; ECG is delayed 5 seconds. - "DELAY" records ECG with a 5 second delay and is for routine recording. - "DIAG" records current ECG (matches most current trace on cardioscope). "DIAG" record is of diagnostic quality and must be used for diagnostic procedures such as 12-lead ECG and stress testing.
7.	BATT LEVEL	Meter indicates battery voltage. When marker is in green zone, battery is charged sufficiently to operate unit. When marker is in red zone, battery needs to be recharged. A depleted battery can be fully recharged in 16 hours by connecting power cord to grounded wall outlet.
8.	BATT CHG	Light indicates battery is being charged.
9.	ECG LEAD SELECT	Rotary switch to select ECG input: STD, patient cable leads I, II, III, AVR, AVL, AVF and V or PADDLES.
10.	PATIENT CONN	Connector for Physio-Control 6-pin patient cable.
11.	QRS	Indicator light flashes when QRS sensed.
12.	HEART RATE	Displays QRS rate from 20-300 bpm.
13.	ALARM LIMITS	Rotary switches for selecting "HIGH" and "LOW" heart rate limits. Violation of these limits will result in continuous alarm through which QRS "beeper" can be heard. To silence alarms, turn limit switches off. Violation of these limits will also initiate 15 second recording anytime recorder switch is set to "AUTO."

Back panel

14.	ECG OUTPUT	ECG output for remote accessory equipment. Connector wired for 1mV and 1V output.
15.	POWER CORD	Connect to grounded wall outlet for line operation. For line operation of interconnected defibrillator and monitor modules, insert monitor power cord into power receptacle at rear of defibrillator module and connect power cord from defibrillator to grounded wall outlet.

220 and 240 VAC models

Note: To operate the LIFEPAK 6s monitor, the front panel "POWER" pushbutton must be depressed (trace will appear on cardioscope). To operate the LIFEPAK 6s defibrillator, the front panel "POWER" pushbutton must be depressed (button will light). The "MAINS POWER ON-OFF" switches on the rear panels serve only to allow mains power as the power source.

For mains power operation of either monitor or defibrillator:

1. Connect mains power cord to "MAINS POWER INPUT."
2. Connect mains power cord to grounded wall outlet.
3. Switch "MAINS POWER ON-OFF" to "ON" position (switch will light). Battery will charge anytime mains power cord is connected and the mains power "ON" is selected. "BATT CHG" indicator on front panel will glow when battery is being charged from mains power.

For mains power operation of both monitor and defibrillator:

1. Connect auxiliary power cord from "MAINS POWER INPUT" receptacle of monitor to "MAINS POWER OUTPUT" receptacle of defibrillator.
2. Connect mains power cord to "MAINS POWER INPUT" receptacle of defibrillator.
3. Connect mains power cord to grounded wall outlet.
4. Switch "MAINS POWER ON-OFF" to "ON" position on both monitor and defibrillator (both switches will light).

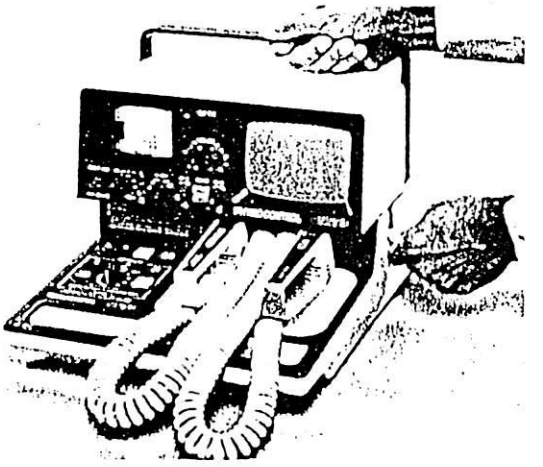
For battery operation of either or both modules:

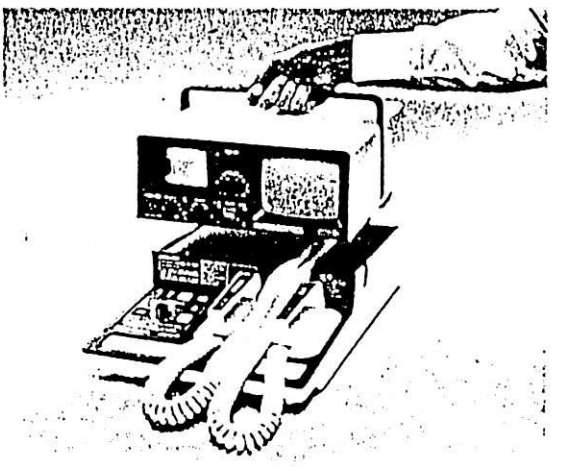
1. Switch "MAINS POWER ON-OFF" to "OFF" position or disconnect mains power cord from wall outlet.
2. Observe the "BATT LEVEL" indicator when DC operation is required. Marker should be in green zone. This indicates battery is sufficiently charged to operate unit, but does not indicate how fully the battery is charged. When mains power is interrupted, the unit will operate from its internal battery, regardless of "MAINS POWER ON-OFF" position.

SLIDE CONNECTOR

The LIFEPAK 6s defibrillator and monitor modules may be operated as single units or, when joined by the slide interconnect, will function together for procedures such as elective cardioversion. To join the units, the monitor is placed above and in front of the defibrillator module (make certain the paddle cords of the defibrillator are tucked into the recessed channel). Line up the monitor feet with the defibrillator slide channels and slide the monitor onto the defibrillator module until it is fully engaged. To separate, push downward on the lock release button on the right side and pull the monitor module forward and up.

When the modules are separated, the electrical slide contacts are exposed. These exposed contacts **do not** represent a safety hazard and are used only to transfer the paddle pick-up of the ECG signal from the defibrillator to the monitor and to transfer low level signals during synchronous cardioversion. No dangerous voltages are present at these contacts.





AC AND DC OPERATION

When a LIFEPAK 6s module is connected to an AC line grounded wall outlet, do not use an adapter. To operate from the internal battery, disconnect from wall outlet. Observe "BATT LEVEL" Marker should be in green zone; this indicates battery is sufficiently charged to operate unit but does not indicate how fully the battery is charged.

When a LIFEPAK 6s module is connected to AC line power, the internal battery will charge regardless of whether the "POWER" is on. A depleted battery can be fully charged in 16 hours. **A new unit or one which has been stored for a prolonged period of time will require charging.** The shelf or storage life (unit unplugged and not operated) of a fully charged battery is approximately one month.

A fully charged monitor battery will typically give 3 hours of cardioscope monitoring or 1 hour of continuous recording at 25°C. A fully charged defibrillator battery will typically deliver twenty-five (25) 360 joule discharges at 25°C.

Important: See *Maintenance* for proper care of internal batteries.

PADDLE MONITORING

Note: Monitor module must be connected to defibrillator module.

- Depress "POWER" switch on monitor module (defibrillator "POWER" does not need to be on).
- Turn "ECG LEAD SELECT" switch fully clockwise to "PADDLES."
- Apply conductive gel to paddles. Keep hands and paddle handles free of gel.
- Place paddles firmly on patient's bare chest with "APEX" paddle (positive pick-up) on patient's lower left and "STERNUM" paddle (negative pick-up) near upper sternum on patient's right.
- Observe cardioscope to determine patient's rhythm.
  Note: "ECG SIZE"may need to be adjusted if "R" wave is not clearly visible on cardioscope.

Paddle monitoring after defibrillation is usually accompanied by a short recovery time of several seconds. This recovery period may appear as an erratic pattern or asystole on the cardioscope. During this short time span, it is not possible to determine defibrillation results from the monitor trace.

PATIENT CABLE MONITORING

The LIFEPAK 6s monitor comes standard with a 5-lead wire, 6-pin connector patient cable. 3 and 4-lead wire cables are optional. If a 3-lead wire cable is used, use cable number 09-10418-01 only (IEC cable 800947-00). The cables are fully shielded to reduce noise to a minimum. To further assure baseline stability and clean trace, the operator should: (1) prepare the patient's skin well prior to electrode application; (2) make certain that electrodes (whether pregelled or not) have sufficient wet gel to conduct; and (3) secure and support the patient cable.

ECG electrode requirements

For best ECG monitoring results, silver/silver chloride electrodes should be used with this equipment. Postdefibrillation recovery of silver/silver chloride electrodes will be much faster than other electrode types; this means that the patient's ECG will be visible on the cardioscope sooner. **Use of stainless steel electrodes should be avoided** since postdefibrillation recovery of ECG data may be delayed for 10 seconds or longer. This extended recovery may simulate asystole or a very rapid tachyarrhythmia and confuse proper diagnosis. If stainless steel electrodes must be used it is recommended that careful patient evaluation combined with a more prolonged period of cardioscope observation take place prior to instituting further electric therapy.

Monitoring procedure

- Attach 6-pin patient cable to "PATIENT CONN."
- Turn "ALARM LIMITS" to "OFF" position.
- Place "ECG LEAD SELECT" in "STD" position.
- Prepare patient's skin for electrode application.
- Apply electrodes to prepared sites. Make certain the gel of pregelled electrodes has not dried. If using nongelled type, apply ¼" -½" gel in mound over contact.
- Attach proper lead wires to electrodes. Select proper lead with "ECG LEAD SELECT."
- AHA color coding for 3, 4, 5-lead wire cables:
  - White - "RA" (or upper right chest)
  - Black - "LA" (or upper left chest)
  - Red - "LL" (or lower left chest)
  - Green - "RL" (or lower right chest)
  - Brown - chest or V leads
- IEC color coding for 3, 4, 5-lead wire cables:
  - Red - right arm or "R" (or upper right chest)
  - Yellow - left arm or "L" (or upper left chest)
  - Green - left leg or "F" (or lower right chest)
  - Black - right leg or "N" (or lower right chest)
  - White - "V" or "C" (chest)

- To do a complete 12-lead ECG using the "ECG LEAD SELECT," it is necessary to use the 5-lead wire cable.
- To obtain the limb leads (I, II, III, AVR, AVL, AVF, but no V leads) using the "ECG LEAD SELECT," it is necessary to use either the 4-lead wire or 5-lead wire cable (chest lead wire will not be used).
- To monitor in modified lead II or any modified chest leads (MCL1, MCL6, etc.) use the 3-lead wire patient cable (cable number 09-10418-01 only). The LL is the positive pick-up, RA is the negative, and RL is the reference electrode. The "ECG LEAD SELECT" must be turned to lead II when this cable is used regardless of electrode placement.
  Note: If the above leads are desired when using the 5-lead wire cable, place the "ECG LEAD SELECT" in lead II and utilize the RA, LL, and RL lead wires only (LA and chest lead wires may be taped together and out of the way).

Heart rate display

- Adjust "ECG SIZE." To properly count heart rate during routine monitoring, the "ECG SIZE" must be adjusted correctly.
- Begin with "ECG SIZE" fully counter-clockwise (but not in x1 position).
- Turn "QRS VOL" to approximately 10 o'clock position.
- Turn "ECG SIZE" clockwise until beeper and "QRS" indicator coincide with each "R" wave, then turn "ECG SIZE" slightly further clockwise.
- Adjust "QRS VOL" as desired. The "R" wave detector selectively detects "QRS" complexes greater than .3 mV in amplitude. It discriminates against noise, muscle artifact, T-waves, and other random signals such as ventricular fibrillation. However, due to the varied nature of these signals, it is possible that some will be counted by the rate meter. Setting "ECG SIZE" as outlined above will minimize this possibility.

Alarm limits

- If use of the optional "ALARM LIMITS" is desired, dial proper "HIGH" and "LOW" limits. **Rate alarms should be set as close as possible to the rate that is expected.** Infrequently, random counting during ventricular fibrillation may prevent the rate alarm from activating if the "LOW ALARM" is set too low.
  Note: When alarm limits are exceeded, audible alarm will sound continously, irrespective of "QRS VOL" setting. Any detected "R" waves will be heard as an alarm tone change.
- To turn off alarm, move the "HIGH" or "LOW" limit beyond the patient's rate.
- Alarm limits must be set if "AUTO" record is desired.

Monitoring pacemakers

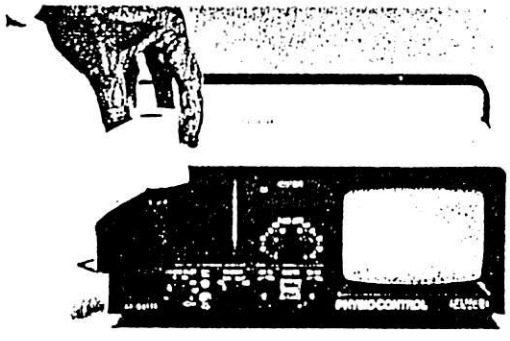
A pacer spike which is of sufficient amplitude and duration will be displayed by the LIFEPAK 6s monitor. Because of the sampling process used with a nonfade cardioscope and of the narrow width of the pacemaker pulse, the amplitude of the spike displayed on the cardioscope may appear variable. This may also occur when recording in "DELAY" mode. This variability should not be confused with pacemaker electrode displacement or malfunction. Recordings done in "DIAG" (diagnostic) mode normally will show pacer spikes of consistently small amplitude.

Large amplitude pacemaker spikes can overload the "R" wave detector circuitry so that no paced "R" waves are counted resulting in "blanking" of the heart rate display. The heart rate meter will not count the pacer spike as an "R" wave. To minimize ECG pick-up of the pacemaker impulse when monitoring unipolar pacemakers, it may be helpful to place the electrodes so that a straight line drawn between the positive and negative electrodes intersects a line between the pacemaker generator and the heart at right angles. Electrode placement will not be as critical when the pacemaker is bipolar.

ECG RECORDING

Paper loading

- Pull out right edge of paper carrier.
- Remove old paper roll.



- Insert new paper roll. Paper must be wound as pictured (grid should face inside of roll).
- Pull out a short length of paper.

- Close paper carrier.
- Put "ECG LEAD SELECT" in "STD" position.
- Turn "RECORDER" to "DELAY" position (monitor "POWER" must be on).
- Feed edge of ECG paper under the roller. Paper should feed out left side of recorder.
- Turn "RECORDER" to "DIAG." Depress "1mV" several times. Compare trace to optimum (see *Maintenance*).

Recording

Recording may be done during paddle monitoring as well as during cable monitoring. "AUTO," "DELAY" time or "DIAG" modes may be selected. "DELAY" mode on the LIFEPAK 6s monitor is always of monitor quality. "DIAG" recording is of diagnostic quality and is usually reserved for diagnostic procedures.

Note: Recording during cardioversion or defibrillation attempts should always be done in "DELAY" mode because recorder recovery is faster in "DELAY."

- Switch recorder to either "DIAG" or "DELAY." To allow capture of recent abnormalities, select "DELAY" mode.
- Adjust "ECG SIZE" if necessary. This knob, when depressed, will also freeze the signal for study of the scope if hard copy is not necessary.

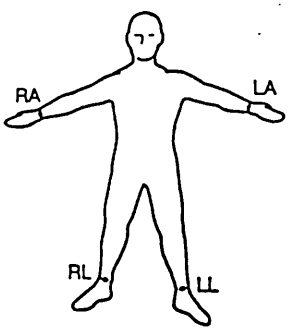
If "FREEZE" is depressed while recording in "DIAG" mode, recording continues uninterrupted. If "FREEZE" is depressed while recording in "DELAY" mode, recording reverts to real-time until "FREEZE" is released. At that time "frozen" information will be recorded and unit then returns to "DELAY" mode.

Auto operation

- Set "ALARM LIMITS" as desired.
- Switch recorder control to "AUTO" position.
- Recorder will start immediately if heart rate display equals or exceeds set "ALARM LIMITS." Recorder will run 18 seconds.

To override 18 second record, switch recorder to "OFF" and then back to "AUTO." If heart rate remains outside of set alarm limits, and further recording is not desired, reset "ALARM LIMITS."

Recorder is activated only once by a continuous violation of set limits.



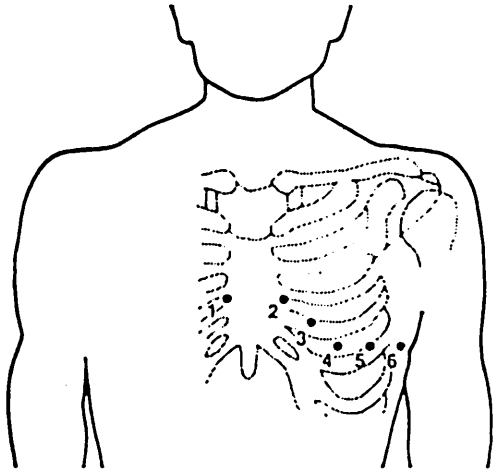
Diagnostic electrocardiograms

- Use 5-lead wire cable.
- Place "ECG LEAD SELECT" in "STD" position.
- Set "ECG SIZE" to x1 position.
- Switch "RECORDER" to "DIAG" position (automatically selects diagnostic frequency response).
- Depress "1mV" knob several times to check for 10mm deflection on ECG paper.
- Turn "RECORDER" to "OFF."
- Prepare patient's skin and attach limb electrodes to patient and attach limb lead wires to proper electrodes (RA, LA, LL, RL). Electrode gel must be used.
- Place "ECG LEAD SELECT" in lead I and "RECORDER" in "DIAG" position. Advance "ECG LEAD SELECT" to record remaining limb leads (I, II, AVR, AVL, and AVF). At least six inches of stable recording should be allowed for each lead.
- Turn "RECORDER" to "OFF."

To record chest or V leads:

- Prepare skin at chest V_1 through V_6 positions.
- Place chest suction cup with attached V lead wire at V_1 position. Electrode gel should fill bell of suction cup.
- Place "ECG LEAD SELECT" in V position.
- Switch "RECORDER" to "DIAG." Turn "RECORDER" to "OFF" after recording at least 6 inches.
- Move suction cup to standard V_2, V_3, V_4, V_5, and V_6 positions and record each. For rapid recorder recovery, return "ECG LEAD SELECT" to "STD" position when moving Welsh electrode. Make certain electrode gel does not become continuous between prepared sites.

  Note: If signal amplitude exceeds the chart paper after initial calibration, it will be necessary to recalibrate with "1mV" knob. Depress several times and adjust "ECG SIZE" so that 5mm square wave is recorded.



There are six standard chest leads:

V_1 - Fourth intercostal space at right border of sternum.

V_2 - Fourth intercostal space at left border of sternum.

V_3 - Midway between V_2 and V_4.

V_4 - Fifth intercostal space, midclavicular line.

V_5 - Same level as V_4, anterior axillary line.

V_6 - Same level as V_4 and V_5, midaxillary line.

Stress testing

The "DIAG" (diagnostic) mode on the LIFEPAK 6s monitor allows it to be utilized as a stress test unit. The fully shielded patient cable allows stable trace at high work loads. The lead configuration used will vary with the physician's personal preference. Care should be taken to support the cable so that there is no tension on the electrode connections. Use of a special anti-static spray on the treadmill will eliminate static buildup on the treadmill and resultant artifact on the cardioscope and recorder. (This problem is most likely to be encountered during dry, cold weather.)

ECG output

The LIFEPAK 6s monitor module has an ECG output on the rear panel which may be used with an ECG modulator or an auxiliary cardioscope or recorder. The output is wired for both high and low level ECG outputs and will accept a standard ¼", 3-conductor phone plug. Wiring of this plug determines the output level (see *Specifications* or Service Manual for wiring information).

DEFIBRILLATION

Defibrillation success is dependent upon many factors; only the mechanical factors will be addressed here.

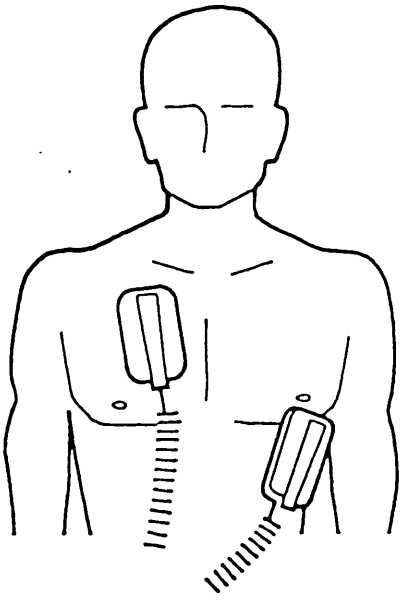
It is important that defibrillation is carried out with as little delay as possible. Paddle position is crucial. The standard paddle placement (anterior-anterior) locates one paddle at the left of the upper sternum (patient's right) and below the clavicle, and the second paddle just to the right of the cardiac apex (patient's lower left chest).* Some clinicians prefer an anterior-posterior paddle placement: one paddle is placed over the cardiac apex and the second is placed posteriorly behind the heart on the patient's back.

Either ECG gel or paste may be used for the conductive interface. Care should be taken not to allow this material to become continuous between the paddle sites or to reach the handles, since the current will follow the line of least resistance and conduct across the chest wall or to the handles, rather than entering the chest cavity. Firmly pressing the paddles against the chest wall helps deliver the current to the thorax. The operator and other members of the resuscitation team should stand clear of the patient and bed during actual defibrillation. Paddles should be cleaned after use to avoid the danger of operator shock (see *Maintenance*).
Caution: Do not operate defibrillator in the presence of high energy electrical fields such as those generated by diathermy. If fibrillation occurs when diathermy is in use, turn off diathermy prior to turning on defibrillator.

*American Heart Association, Advance Cardiac Life Support, Sec. V.5, pub. 1975.

Defibrillation procedure

- Apply conductive gel to paddles.
- Turn defibrillator power on by depressing (1) "POWER" button. Button will light.
- Select energy to be delivered with (2) "ENERGY SELECT" switch.
- Depress and release (3) "CHARGE" button on defibrillator front panel or on "APEX" paddle ("CHARGE" button and charge indicator will flash and numbers will "scroll up" in energy display window until energy reaches preselected level).
  Note: If "ENERGY SELECT" is changed after "CHARGE" is initiated, the charge will be dumped internally. If a much lower energy setting is selected it will not be possible to recharge for 1-12 seconds since the energy stored in the defibrillator must fall below the newly selected setting before recharge can occur.
- Place defibrillator paddles firmly on patient's chest. "STERNUM" paddle is generally placed near the upper sternum and slightly toward the patient's right shoulder. "APEX" paddle is placed near the cardiac apex or on the lower left chest.



- When the energy selected is lit in the energy display window and the message "AVAILABLE ENERGY" is backlit, the defibrillator is ready. "CHARGE" button and charge indicator will glow steadily.
- (1) Discharge defibrillator by depressing both paddle discharge buttons simultaneously.
- Observe patient and cardioscope to determine results. If repeat countershock is necessary, depress "CHARGE" button and repeat as above.
- To turn off defibrillator, depress (2) "POWER" button again. Power light will go out.
- Clean defibrillator paddles and store.
  Note: Defibrillator will not fire while indicators are flashing.

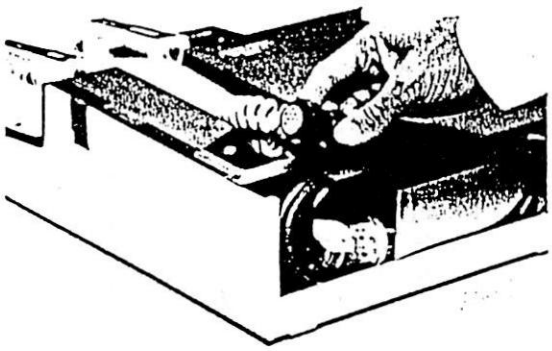
Defibrillator energy will remain charged for approximately 60 seconds. Energy display window will blank when energy is no longer available for discharge. Depress "CHARGE" button again if necessary.

Do not keep defibrillator energy charged continuously for periods in excess of fifteen minutes. To do so may cause damage.

The LIFEPAK 6s defibrillator has an automatic "refresh." Refresh keeps the selected energy essentially constant during the 60 seconds the energy is available for discharge. Slight dimming of the lighted defibrillator controls may occur during refresh and is normal.

Internal defibrillation

For internal defibrillation, the external paddles are disconnected (the LIFEPAK 6s monitor module must be separated from the defibrillator module to expose the paddle connect) and the connector for the internal handles is then attached. (Line up the markers, push on, and screw on with fingers only.) The sterile internal paddles are screwed into the sterile handles. The two modules can then be reconnected.



- Turn "POWER" on (depress button).
- Select energy with "ENERGY SELECT." Delivered energy is limited to 5, 10, 20, 30, and 50 joules with internal paddles. Unit will not charge or deliver higher energies with internal handles connected. Current literature indicates that 90% of adult human hearts can be defibrillated with 10 joules or less delivered directly to the heart.
- Place paddles over right atrium and left ventricle.
- Depress "CHARGE" button on instrument.
- When selected energy is displayed in energy display window and "AVAILABLE ENERGY" is backlit, depress and release "INTRNL PADDLE DISCHG" to deliver energy as directed by person holding paddles.

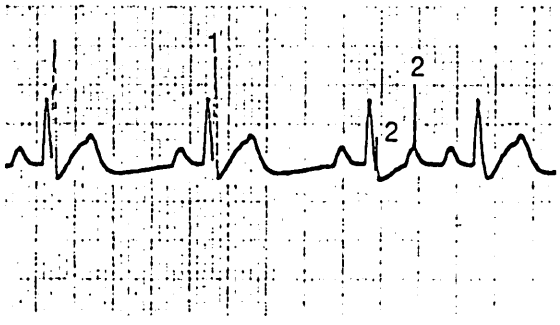
Synchronized cardioversion

For proper synchronization, "ECG SIZE" must be adjusted correctly.

- Defibrillator and monitor modules must be connected.
- Turn on "POWER" to monitor module.
- Attach patient cable and electrodes. Electrodes should be placed away from paddle sites and such that resultant lead will give a tall "R" wave. **Caution: Do not** use defibrillator paddles as ECG pick-up for elective cardioversions. Once discharge pushbuttons are depressed, artifact from poor paddle contact or movement of paddles could cause synchronizer to fire defibrillator prematurely.
- Select lead with "ECG LEAD SELECT" (lead II for 3-lead wire cable).
- Depress "SYNC" button. The "SYNC" button will light when the unit is in synchronous mode.
- Begin with "ECG SIZE" fully counterclockwise (but not in x1 position).
- Turn "ECG SIZE" clockwise until sync marker first appears on QRS complex.
- Turn "ECG SIZE" slightly further clockwise (⅛ to ¼ turn) so that all markers fall near peak or on downslope of the QRS complex.
- Apply conductive gel to paddles.
- Turn on defibrillator module (depress "POWER" button).
- Select energy to be delivered with "ENERGY SELECT."
- Observe cardioscope. Adjust "ECG SIZE" so that all sync markers occur within the QRS complex. Marker will appear to move slightly from complex to complex. This is normal. Markers indicate the identification point of the QRS complex which will be used for synchronized discharge of the defibrillator. Sync markers occurring on the "S" wave or "J" point can normally be moved backward on the QRS complex by adjusting "ECG SIZE." If marker does not appear on the scope or appears anywhere other than on the QRS, adjust "ECG SIZE" or select another lead. "SYNC" light on defibrillator module will blink off with each detected "R" wave.
  Note: For inscription of sync marker on ECG recordings, use "DELAY" mode.
- Place paddles on patient's chest wall as described under *Defibrillation procedure*.
- Charge defibrillator. Unit is ready when the energy selected is displayed in the energy display window and "AVAILABLE ENERGY" is backlit. Charge indicator glows steadily.
- **Depress and hold** pushbuttons on paddles until discharge occurs with next "R" wave. Release.
- If rhythm does not convert and cardioversion is to be reattempted, it is necessary to depress "SYNC" button again (button will light) since unit switches back to defibrillation mode automatically after each synchronous discharge.
- **Clean** and store paddles after procedure.

Note: It is a fairly common practice to "test" a defibrillator prior to use for synchronized cardioversion. The patient's ECG signal is utilized and, with the defibrillator in synchronous mode, the defibrillator is fired into the test load while the cardioscope and/or recorder is observed. In this test situation, most cardioscopes and recorders saturate (ECG trace disappears from cardioscope, and recorder stylus "straight lines" at upper or lower margin of paper) almost immediately after the energy is transferred. The initial point of saturation has generally been considered to be coincident with energy transfer, although technically, accurately determining the point of energy transfer can only be done by gaining access to the internal circuitry.

In the case of the LIFEPAK 6s defibrillator/monitor, this "test" will not cause the cardioscope or recorder to saturate. The trace may show a small, narrow spike which is an artifact induced by return of the relay arm within the defibrillator. The spike is evident in figure below. It does not represent any energy transfer.



1. "SYNC" marker extending top of "R" wave.
2. Spike.

The spike will not be apparent during actual cardioversion attempts; only during this test procedure.

The LIFEPAK 6s defibrillator/monitor is fully compliant with the 1981 AAMI standard for synchronized cardioversion. The standard requires initiation of the discharge within 30 msec. of the synchronizing signal.

Routine testing of the unit not only will serve to detect possible mechanical problems, but will keep personnel acquainted with normal operating procedure.

MONITOR

- Turn "ALARM LIMITS" to "OFF" position and "QRS VOL" to left.
- "RECORDER" switch should be in "AUTO" position.
- Place "ECG LEAD SELECT" in "STD" position.
- Turn "ECG SIZE" to x1 position.
- Attach patient cable to "PATIENT CONN."
- Connect line to grounded wall outlet. For 220 or 240 VAC models, switch "MAINS POWER ON-OFF" to "ON" position.
- Push "POWER" button. (Observe "BATT LEVEL." Marker should be in green zone. If the unit is operated from an AC line, "BATT CHG" light should also be on.)
- Depress and release "1mV" knob - calibration signal should appear on scope.
- Adjust "QRS VOL" so that beep is heard with each "1mV" signal.
- Depress "FREEZE" knob. Trace on cardioscope (use "1mV") should be stationary.
- Move "ALARM LIMITS" ("LOW") from "OFF" position - alarm should sound and recording begin.
- Move low "ALARM LIMITS" to "OFF."
- Turn "ECG LEAD SELECT" to lead I - interference should be present on cardioscope with 4 or 5-lead wire cable. Place snap ends of white lead wire and black lead wire together - trace on cardioscope should stabilize. Repeat process for lead II using white lead wire and red lead wire, for lead III utilizing black and red. If utilizing 3-lead wire cable, (09-10418-01) test with "ECG LEAD SELECT" in lead II and connect white and red lead wire only.
- Turn "ECG LEAD SELECT " to "STD".
- Turn "RECORDER" switch to "DELAY" - recorder should begin running and trace should appear within one second. Depress "1mV" several times. Calibration signal should appear on scope and be recorded on ECG paper approximately 5 seconds later.
- Turn "RECORDER" to "DIAG" and depress "1mV" several times. Calibration signal should appear "square" on recorder without overshooting or rounding (see *Maintenance*). Square wave should be 10mm high on recorder.
- Turn "RECORDER" to "OFF."

DEFIBRILLATOR

- Paddles should be firmly seated in storage area ("TEST LOAD").
- Connect cord to grounded wall outlet. For 220 or 240 VAC models, switch "MAINS POWER ON-OFF" to "ON" position.
- Depress "POWER" button. Button will light. (Observe "BATT LEVEL." Marker should be in green zone. If the defibrillator is operated from an AC line, "BATT CHG" light should also be on.)
- Select energy with "ENERGY SELECT." Use 100J or 360J for readout of energy delivered to test load.
- Depress "CHARGE" button. Numbers in energy display window will scroll to selected energy and "AVAILABLE ENERGY" will be backlit. Button will flash until fully charged. "CHARGE" indicator on "APEX" handle will also flash until ready. Charge cycle should take less than 10 seconds for 360 joules.
- Discharge defibrillator by firmly pressing down on paddles and depressing both paddle discharge buttons simultaneously. Delivered energy will be displayed in energy display window and message "TEST LOAD" backlit.
  Note: Because of heat created by discharging into "TEST LOAD," do not repeat testing of defibrillator more often than 10 times per hour. Do not "open air" discharge. Do not turn off "POWER" to "dump" a charge more than 10 times per hour.

MONITOR AND DEFIBRILLATOR

- Connect cord to grounded wall outlet. For 220 or 240 VAC models, switch "MAINS POWER ON-OFF" to "ON" position.
- With units interconnected, turn "POWER" on for monitor.
- Turn "ECG LEAD SELECT" fully clockwise to "PADDLES." Touch one paddle face - cardioscope should show interference. Repeat with second paddle.
- Place paddle faces together - interference should show on cardioscope.
- To test synchronizer:
  - Defibrillator and monitor modules must be connected.
  - Connect monitor module to patient or ECG simulator* via patient cable.
  - Observe cardioscope - select lead with tall "R" wave.
  - Turn defibrillator (1) "POWER" on.
  - Depress "SYNC" button. Turn "ECG SIZE" fully counterclockwise and advance slowly clockwise until marker appears near upper portion of "R" wave. Button should light and blink off with each detected "R" wave. Heart rate display should be updating.
  - Seat paddles firmly in storage area. Select energy on (2) "ENERGY SELECT."
  - Charge defibrillator.
  - Depress and hold both paddle pushbuttons simultaneously until defibrillator discharges on next "R" wave.
  - Defibrillator should return to defibrillation mode ("SYNC" light no longer on).

  *Since the "R" wave generated by an ECG simulator is often very "fast" it may not be sensed consistently by the synchronizer circuitry. The ECG simulator method, therefore, is less desirable.

INTERNAL BATTERIES

The internal batteries of the LIFEPAK 6s defibrillator and monitor modules are nickel-cadmium. This type of battery was chosen for its performance, tolerance to overcharge, and easy care.

It is recommended that the LIFEPAK 6s modules be connected to AC line power when not in use. Optimum battery performance will occur when the unit is operated and charged at normal room temperatures. When unit is charging, ambient temperatures greater than 40°C may adversely affect battery capacity.

The life expectancy of nickel-cadmium batteries is dependent upon many variables, but the primary factors are temperature and use. Generally a battery should be replaced when its capacity measures less than 70% of its rating. For detailed information and test procedures see Physio-Control technical paper, "Nickel Cadmium Batteries " (P/N 803642-00). Battery maintenance and testing should be referred to qualified service personnel.
Caution: Do not discharge the internal batteries completely. To do so will cause damage. Turn power off when not in use. Connect to AC line power when either "BATT LEVEL" indicator is in red zone or when unit is not in use.

See Operating and Service Manual for further information.

CLEANING THE DEFIBRILLATOR/MONITOR

The LIFEPAK 6s defibrillator/monitor case, paddles, cables, test load contacts, recorder platen, and cardioscope screen should be cleaned with mild soap and water. Use a damp sponge or towel to clean. **Do not immerse any portion of the LIFEPAK 6s defibrillator/monitor in water.** Do not use alcohol or ketones (MEK, acetone, etc.).

Do not gas sterilize external adult paddles.

Do not autoclave any Physio-Control defibrillator paddles **except** internal paddle spoons (paddles must be separated from handles). Internal paddle spoons will tolerate short-term autoclaving up to 290°F and long-term autoclaving up to 260°F.

Internal paddle handles and cables may be gas sterilized together, and will tolerate up to 150°F.

Clip-on posterior and pediatric paddles may be gas sterilized. Gas sterilization of paddles must be in accordance with procedures accepted by the Joint Commission on Accreditation of Hospitals and as recommended by the gas sterilization equipment manufacturer.

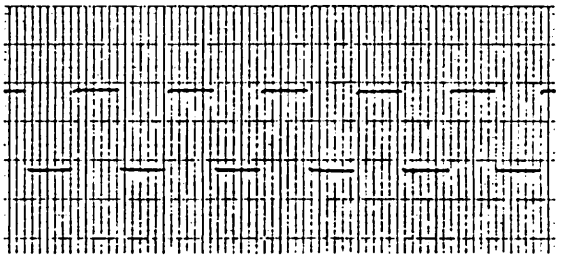
Special care should be taken to clean the defibrillator paddles after each use. Build-up of gel will not only interfere with ECG pick-up through the paddles (artifact will be evident), but could produce a shock hazard to the operator if dried (or wet) gel accumulates between the paddle surfaces and the operator handles. Clean paddle storage area anytime it becomes soiled with gel.

If any fluid or gel is evident in the cassette storage well, refer unit to qualified serviceperson before further use.

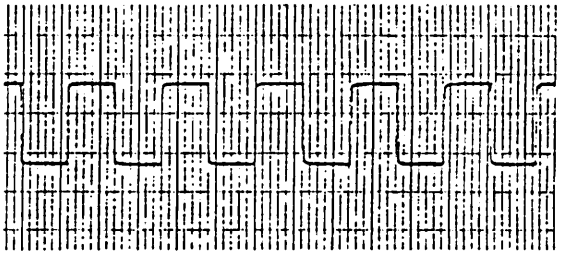
RECORDER STYLUS

Adjustment
With "ECG SIZE" set to x1 position and recorder in "DIAG" mode, the square wave should appear as pictured under "optimal." See Service Manual for adjustment procedure.

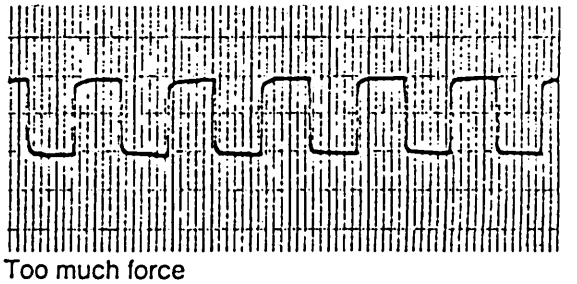
Styli are preadjusted at the factory and should need very little adjustment if any. As the stylus ages, residue may build at the point where it contacts the paper and make the trace appear fuzzy. This residue can be removed with a pen-knife.



Too little force



Optimum force



Too much force

TESTING AND MAINTENANCE GUIDELINE

Physio-Control LIFEPAK defibrillator/monitors are designed and manufactured to be reliable and to require minimal maintenance. Routine periodic testing and maintenance will help to ensure that this instrument remains in good operating condition and is ready for use when needed. It will also promote operator familiarity with the defibrillator/monitor.

The following guideline is intended to test the functional and electrical safety of the defibrillator/monitor at periodic intervals. It complements the internal quality assurance programs of the hospital, clinic, or emergency medical service.

Testing should be accompanied by a thorough visual inspection of the defibrillator/monitor. The unit should be examined for cracks in the case, power cords, paddles, coil cords and strain relief bushings; for pitted paddle plates; for the presence of gel on paddles or paddle storage and for the proper function of controls. If necessary, corrective action should be taken immediately.

While examining the unit, the operator should ensure that all accessories (e.g., internal defibrillation cables and paddles, patient cable, pediatric paddle adaptors, etc.) are present and functional.

Routine testing of defibrillator/monitors operating from battery power will consume battery power. The operator should assure that batteries are promptly recharged according to the procedure in the Operating Instructions.

Physio-Control recommends the following minimum program of routine testing and maintenance. Consult the Operating Instructions and Service Manual provided with the defibrillator/monitor for specific instructions. If necessary, replacement manuals may be obtained from your local Physio-Control Sales and Service office.

	Clinical Staff				Biomedical Engineering
Procedure	**Daily**	**After Use**	**As Required**	**Weekly**	**Quarterly**
Clean defibrillator/monitor		•	•		•
Ensure that all supplies and accesories are present and in operating condition (e.g., gel, ECG paper, patient cable, electrodes etc.)	•	•	•		
Check/change recorder paper		•			
Operational tests: monitor function			•		•
defibrillator discharge	•				•
Inspect case and power and paddle cords for damage				•	•
Verify that paddles are clean	•	•			
Replace/adjust recorder stylus			•		
Electrical safety test, performance verification, and calibration check					•

If a discrepancy in monitor operation is found, ensure that corrective action is taken immediately.

This brief checklist is intended for non-technical personnel. If trouble persists after consulting this guide, call your area service technician. A complete troubleshooting guide can be found in the Service Manual.

DEFIBRILLATOR

Trouble	Possible cause
1. Unit does not function when "POWER" pushbutton is depressed. "POWER" button does not light.	1A. Internal battery operation (DC): - Battery discharged below operating level. 1B. Line operation: - Unit not plugged in. - Defective power cord. - Blown fuse or tripped circuit breaker in building.
2. Charge time to 360 joules exceeds 10 seconds.	2A. Internal battery level low.
3. Energy is not delivered to patient when both paddle pushbuttons are depressed.	3A. Unit in "SYNC" mode and no "R" waves are detected. 3B. Defibrillator has not reached full energy selected or too much time has elapsed and energy is no longer available for discharge (energy display window blank, "CHARGE" and charge indicator unlit). 3C. Charge has been "dumped" due to changed "ENERGY SELECT" after charge initiated. (No indicators lit.) 3D. Discharge pushbuttons released too quickly. Depress simultaneously for at least 0.1 second.
4. Numbers in energy display window scroll very slowly when "CHARGE" depressed.	4A. Internal battery level low. Connect to line power.
5. Displayed "AVAILABLE ENERGY" in energy display window does not match energy selected.	5A. Defibrillator energy storage may not meet specifications. Call service.
6. Numbers do not appear in energy display window when "CHARGE" depressed.	6A. Defibrillator "POWER" not on. 6B. DC operation: internal battery discharged below operating level.
7. Bars (not numbers) displayed in energy display window when 100J or 360J selected and dumped into "TEST LOAD."	7A. Defibrillator energy output may not meet specifications. Call service.
8. Energy display window blank when 100J or 360J selected and dumped into "TEST LOAD."	8A. Defibrillator energy transfer timing may not meet specifications. Call service.
9. "BATT LEVEL" remains in red zone despite charging attempts. Unit operates normally on line power (AC).	9A. Call service.
10. "BATT CHG" does not light when unit connected to line power but unit is otherwise operational.	10A. Defective light. 10B. Defective power cord. Unit operating from internal battery (DC). 10C. Building fuse blown or circuit breaker tripped. Unit operating from internal battery.
11. "SYNC" light does not flash when "SYNC" mode selected.	11A. Unit not connected to LIFEPAK 6s monitor module. 11B. "R" wave amplitude too low to be sensed. Increase "ECG SIZE" or select lead with larger "R" wave. 11C. Poor electrical connection in slide connector.

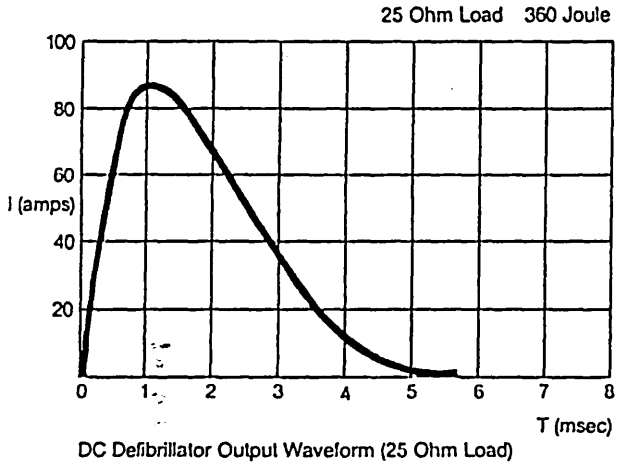
MONITOR

Trouble	Possible cause
1. Unit does not function when "POWER" pushbutton is depressed (no trace on cardioscope). Note: Monitor power button does not illuminate.	1A. Battery operation (DC): - Battery may be discharged below operating level. ("BATT LEVEL" marker will be in red half.) Test by utilizing line power. 1B. Line operation (AC): - Unit not plugged in. - Defective power cord. - Blown fuse or tripped circuit breaker in building.
2. Interference on cardioscope when using patient cable as ECG pick-up.	2A. Patient cable not connected to unit. 2B. Poor skin preparation, electrode contact, or electrode placement. 2C. Defective or incorrect patient cable. 2D. Strong radio frequency electrical field present in area (such as diathermy). Turn equipment off.
3. Excessive interference or 60-cycle interference on cardioscope when using paddles for ECG pick-up. (Monitor and defibrillator must be connected.)	3A. Paddles dirty. 3B. "ECG LEAD SELECT" not on "PADDLES." 3C. Slide connector contacts defective.
4. No ECG signal on cardioscope when using patient cable, but full calibration display is available.	4A. "ECG LEAD SELECT" turned to "STD" or "PADDLES." 4B. Defective patient cable.
5. No ECG signal on cardioscope with paddle pick-up, but "1mV" pulse fully adjustable. (Monitor and defibrillator must be connected.)	5A. "ECG LEAD SELECT" not in "PADDLES" position.
6. Recorder does not run.	6A. Monitor "POWER" not on. 6B. If operating from internal battery, try AC line power.
7. Recorder runs but no trace on paper.	7A. Stylus bent or misadjusted. (See Operating and Service Manual for adjustment procedure.)
8. Straight line only on cardioscope and recorder when signal is applied or "1mV" knob is depressed.	8A. "ECG SIZE" turned to minimum "SIZE" position.
9. No systole sound.	9A. "QRS VOL" turned fully counterclockwise. 9B. "ECG SIZE" too low for "R" wave detection. 9C. Amplitude of ECG signal too low in that lead. Select another lead or move electrodes.
10. No "SYNC" marker (monitor and defibrillator must be interconnected).	10A. Unit not in synchronous mode. 10B. ECG size too low to be detected. Adjust "ECG SIZE," "ECG LEAD SELECT," or electrode positions. 10C. Poor connection in slide connector.
11. "QRS" light fails to flash with each QRS.	11A. "ECG SIZE" adjusted too low. 11B. Amplitude of ECG signal too low in that lead. Select another lead.
12. "HEART RATE" does not register.	12A. "ECG SIZE" adjusted too low. 12B. Amplitude of ECG signal too low in that lead. Select another lead or move electrodes.

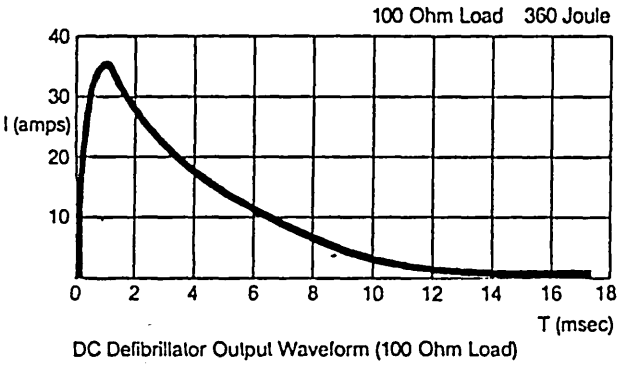
13.	"BATT LEVEL" remains in red zone despite charging attempts. Unit operates normally on line power (AC).	13A. Call service.
14.	"BATT CHG" fails to light when unit connected to AC line power. Unit otherwise operational.	14A. Light defective. 14B. Power cord defective - unit operating from internal battery. 14C. Building fuse blown or circuit breaker tripped. Unit operating from internal battery.
15.	"AUTO" record fails to activate.	15A. "ALARM LIMIT" not set.

DEFIBRILLATOR

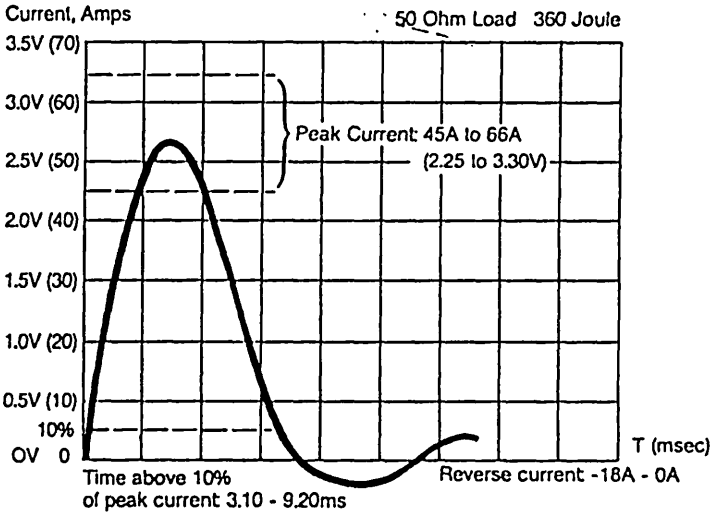
WAVEFORM	5 millisecond monophasic pulse (Edmark) per AAMI Standard.



DC Defibrillator Output Waveform (25 Ohm Load)



DC Defibrillator Output Waveform (100 Ohm Load)



DC Defibrillator Output Waveform (50 Ohm Load)

OUTPUT ENERGY (Assuming 50 ohm load)	5, 10, 20, 30, 50, 100, 150, 200, 300, 360 joules. Internal paddles; 5, 10, 20, 30, 50 joules. Defibrillator output electrically isolated.
TEST LOAD (50 ohm)	Verifies energy delivery accuracy (±15%) and timing (within 30 msec) at 100 and 360 joule setting.
CHARGE CONTROL	Independent momentary pushbutton controls on front panel and "APEX" paddle.
CHARGE INDICATORS	Flashing lamps on paddle and front panel along with incrementing digital display indicate charge in progress. Upon full charge "AVAILABLE ENERGY" annunciator illuminates and 3-digit display shows energy available for discharge.
CHARGE TIME	Charge to 360 joules in less than 10 seconds at 25°C when AC operated, or DC operated from a fully charged battery. Charge to 360 joules in less than 12 seconds when DC operated after 15 maximum energy discharges.
OUTPUT PADDLE	Electrode area: 82 cm² Cord length: 3 m (10 ft) Discharge control: discharge controls on both paddles in series.
DEFIBRILLATOR SYNCHRONIZER	Synchronizes defibrillator pulse to patient-generated "R" wave. Sync indicator: marker on cardioscope identifies synchronizer trigger point. Defibrillator will discharge within 20 ms after marker. Marker also appears on ECG recorder when in "DELAY" mode. Sensitivity control: ECG size control acts as threshold control.

AC INPUT OPTIONS	100, 117, 220, 240, ±10% VAC, 50 or 60 Hz
BATTERY TYPE	Nickel-cadmium, 12 V, 1 Ah
BATTERY CAPACITY	Typically twenty-five (25) 360 joule discharges at 25°C. Also applicable at 20°C.
BATTERY METER	Indicates approximate voltage level of defibrillator battery.
BATTERY CHARGING INDICATOR	Illuminates when battery is charging.
BATTERY CHARGE TIME	16 hours for depleted battery.
MAXIMUM POWER CONSUMPTION	160 watts during defibrillator charge.
SIZE	48.9 cm L; 30.5 cm W; 11.4 cm H (19.25 in; 12 in; 4.5 in)
WEIGHT	8.98 Kg (19.75 lbs)

ECG MONITOR

INPUT	Isolated ECG via QUIK-LOOK defibrillator paddles when ECG monitor module connected to defibrillator module. Isolated ECG via 3, 4, or 5-lead patient cable, 6-pin patient cable connector per AAMI ECG Connector Standard (draft), AAMI ECGC-D 10/79.
PATIENT CABLE LENGTH	4.0 m (13 ft); cable 3.1 m (10 ft); leads .9 m (3 ft)
COMMON MODE REJECTION	100 dB minimum with respect to chassis ground with 51K ohms imbalance at 60 Hz. 65 dB minimum with respect to isolated ground.
CARDIOSCOPE DISPLAY	Size: 76 mm (3 in) x 102 mm (4 in), non-fade Sweep speed: 25 mm/sec Frequency response (-3 dB): .5 Hz to 30 Hz
RECORDER DISPLAY	Paper size: 50 mm x 30 m (100 ft) Paper speed: 25 mm/sec Recorder modes: real-time or delayed by approximately 5 seconds. Frequency response: .05 Hz to 100 Hz (DIAG) .5 Hz to 40 Hz (DELAY)
HEART RATE METER	3-digit readout displays rates from 30 to 300 beats/minute.
ECG OUTPUT	1V/mV and 1mV/mV, .05 Hz to 100 Hz
FREEZE CONTROL	Momentary pushbutton switch.
CALIBRATION	Momentary pushbutton switch simulates 1 mV signal to preamplifier.
AC INPUT OPTIONS	100, 117, 220, 240, ±10% VAC 50 or 60 Hz
BATTERY TYPE	Nickel-cadmium, 14.4 V, 1.5 Ah
BATTERY CAPACITY	Typically 3 hours continuous cardioscope monitoring or 1 hour of continuous recording (or any linear combination) at 25°C, with a heart rate of 60 and a 1.5 cm cardioscope display.
BATTERY METER	Indicates approximate voltage level of monitor battery.
BATTERY CHARGING INDICATOR	Illuminates when battery is charging.
BATTERY CHARGE TIME	16 hours for depleted battery.
MAXIMUM POWER CONSUMPTION	30 watts during cardioscope monitoring. 45 watts while recording.
SIZE	27.3 cm L; 30.5 cm W; 11.4 cm H (l0.75 in; 12 in; 4.5 in)
WEIGHT	6.70 Kg (14.75 lbs)

ENVIRONMENTAL

ATMOSPHERIC PRESSURE	500 mmHg to 775 mmHg
RELATIVE HUMIDITY	0 to 95% (non-condensing)
TEMPERATURE	0°C to 45°C operating, -30°C to 65°C storage.
	All specifications at 25°C unless otherwise stated.

Additional paddles available

800441-02	Internal paddle handles and connector
	Internal paddles for use with 800441 (select paddles size below):
802154-10	2.5 cm (1.0 in) diameter, pair
802154-11	3.8 cm (1.5 in) diameter, pair
802154-12	5.1 cm (2.0 in) diameter, pair
802154-13	6.4 cm (2.5 in) diameter, pair
802154-14	8.9 cm (3.5 in) diameter, pair
800418-00	Pediatric paddle, external (2 required). Slips on to standard adult, QUIK-LOOK, QUIK-CHARGE paddles.
802461-00	Posterior paddle, external, adult. Slips on to apex paddle of standard adult, QUIK-LOOK, QUIK-CHARGE paddles.

Accessories

800153-00	Electrode accessory kit, 12-lead: Contains 4 metal adult limb electrodes (9-10179-00), 4 adult limb straps (9-10181-00), 1 30 mm suction cup electrode (9-10183-00), and 1 5-lead, pin type, patient cable with 6-pin connector (9-10417-00)
800289-00	Patient cable, 4-lead, 6-pin connector, snap-type, low noise
9-10418-02	Patient cable, 3-lead, 6-pin connector, snap-type, low noise (gives leads I, II, and III only)
800539-02	Emergency cart: 3 drawers, flip-up workshelf, swivel casters, tubular top railings (double as handles), cardiac board, IV pole, and "lock" system.
200349-001	Red security ties for emergency cart, 50 ties/package

Replacement Items

	LIFE•PATCH® ECG electrodes, adult:
800139-075	Box of 75
800139-300	Case of 300, 4 boxes/case
	DERMA JEL® electrode jelly:
9-10236-00	4 oz. tube
9-10236-012	Twelve tubes/case
	ECG paper, chemical, 50 mm x 30 m (100 ft), 40 mm grid:
801262-003	3 rolls/box
801262-150	50 boxes/case
9-10417-00	Patient cable, 5-lead, 6-pin connector, snap-type, low noise, provides 12-lead capability
200521-000	Welsh suction cup electrode, 18 mm, for use with snap-type patient cables only
801972-04	Operating instructions: defibrillator/monitor
803195-02	Service manual: defibrillator/monitor
801590-00	Stylus replacement kit, includes stylus insertion tool
801470-00	Stylus adjustment tool

WARRANTY POLICY

Refer to the product warranty statement included in the accessory kit shipped with the product. Duplicate copies may be obtained from your local Physio-Control Sales and Service office.

SERVICE

Should your LIFEPAK 6s defibrillator/monitor require service, contact your Physio-Control service department. When calling to request service, please identify model and serial number and describe problem. If the instrument must be shipped to the service center or factory, special packing is necessary to prevent shipping damage.

Circuit diagrams, component parts lists, calibration instructions, and other relevant technical information are found in the LIFEPAK 6s defibrillator/monitor operating and service manual, P/N 801971. This manual is available through your local Physio-Control office.

SYMBOLS

The symbols below may be found on various configurations of the LIFEPAK 6s defibrillator/monitor.

Defibrillation protected, type BF patient connection

Defibrillation protected, type CF patient connection

Attention, consult accompanying documents

Caution, high voltage

Protective earth (ground)

Off (Power: disconnection from the mains)

ON (Power: connection to the mains)

Fusible link

Equipotentiality connector

INDICATIONS, CONTRAINDICATIONS AND PRECAUTIONS FOR DEFIBRILLATOR USE

This Physio-Control defibrillator/monitor is a therapeutic medical device intended for use under the direction or guidance of a physician. Direct current defibrillation is a recognized means of terminating certain potentially fatal cardiac arrhythmias.

A direct current defibrillator applies a brief high-energy pulse of electricity to the heart. This energy may be delivered either through external paddles or electrodes on the chest, or through internal paddles applied directly to the heart.

Defibrillation is only one aspect of the medical care required to resuscitate a patient in ventricular fibrillation. Depending on the situation, other supportive measures may include:

- establishment and maintenance of a patent airway
- ventilation, including administration of oxygen
- maintenance of blood circulation
- pharmacologic measures

Among other factors, it is recognized that the likelihood of successful resuscitation of a patient depends on the length of time between the onset of ventricular fibrillation and defibrillation. Rapid defibrillation and prompt follow-up care are essential. The physiological state of the patient may affect the likelihood of defibrillation or skeletal muscle contractility. Thus, failure to convert the arrhythmia or to resuscitate a patient is not a reliable indicator of defibrillator performance. Similarly, the patient's muscular response to the defibrillator shock is not a reliable indicator of the energy delivered.

A defibrillator may also be used to terminate certain other arrhythmias. This procedure, synchronized cardioversion, may be an elective procedure, or it may be performed in an emergency if the patient's condition is deteriorating. In synchronized cardioversion the defibrillator's energy is delivered in synchrony with the QRS complex of the electrocardiogram. Discharge on the QRS complex avoids the "vulnerable" period which occurs during ventricular repolarization (T wave) and will reduce the risk of precipitating ventricular fibrillation or accelerating the arrhythmia.

INDICATIONS FOR DEFIBRILLATOR USE

Asynchronous

1. Ventricular fibrillation
2. Ventricular tachycardia with cardiovascular collapse (when preparation for synchronized cardioversion may cause unacceptable delay)

Synchronized cardioversion

Rhythms which are commonly cardioverted include:

1. Atrial fibrillation or atrial flutter
2. Paroxysmal atrial tachycardia or junctional tachycardia
3. Ventricular tachycardia

CONTRAINDICATIONS

1. Idiojunctional or idioventricular rhythms
2. Second or third degree heart blocks
3. Digitalis toxicity

PRECAUTIONS

Because of the high energy delivered by the defibrillator, certain precautions should be taken:

1. Ensure that all defibrillator operators are thoroughly familiar with the Operating Instruction manual, indicators, controls, and their functions.
2. Ensure that the defibrillator is kept in proper operating condition at all times through routine maintenance and repair by qualified personnel. See the Service Manual for details.
3. If battery powered, ensure that the batteries are kept charged and ready for use. Also, ensure that battery maintenance procedures are followed. See Operating Instructions for details. If the integrity of the grounding system is in doubt, the unit should be operated from internal batteries.
4. Before delivering a defibrillator shock, verify that the patient's rhythm is one for which a shock is indicated. Eliminate sources of electrocardiograph (ECG) artifact by assuring good electrode contact with the skin, minimizing motion of patient and electrode cables (this may necessitate a brief (less than 5 to 10 seconds) interruption in cardiopulmonary resuscitation), and by using adequate conductive gel, interface material, or adhesive defibrillation electrodes. Radio transmitters and diathermy equipment may also be a source of ECG interference. If the patient ECG is monitored through defibrillator paddles, make certain that the lead selector is set to "PADDLES."
5. Protect the patient from skin burns by using an adequate amount of an appropriate conductive material. Be sure that the gel or conductive pads cover the entire surface of the paddle electrode yet do not become continuous from one paddle to the other, and that the gel or pads do not dry. Ensure that self-adhesive defibrillation electrodes remain firmly attached to the skin.
6. Apply gel, paste or defibrillation electrodes before turning on the defibrillator.
7. Disconnect from the patient any equipment which may be damaged by the defibrillator shock. This may include external transvenous pacing devices.
8. If the patient has an implanted pacemaker, check pacemaker function following defibrillation or cardioversion.
9. Press paddles firmly to the patient's chest.
10. Do not place defibrillator paddles, electrodes, gel, or pads in contact with ECG monitoring electrodes.
11. Always use the patient cable for ECG monitoring during synchronized cardioversion. This will reduce the possibility that discharge may be inadvertently triggered by paddle motion. Also, refer to Operating Instructions for information on setting the "ECG SIZE" control for proper R-wave sensitivity.
12. Be sure that gel is not in contact with the operator's hands on the paddles.
13. Ensure that all personnel are clear of the patient before delivering a shock.
14. During defibrillation, the operator should not make any contact with the patient except through the defibrillator paddle handles. The operator should also avoid contact with metal objects such as bed frames or stretchers which may provide unwanted current pathways.
15. Do not discharge the defibrillator to "open air." To remove unwanted charge, turn the defibrillator to the OFF setting.
16. Do not discharge the defibrillator with the paddles shorted together. Doing so may cause pits on the paddles which can increase the risk of patient burns. Use a defibrillator test load.
17. Treat a defibrillator with respect. Do not touch the metal paddle plates, defibrillation electrodes, or hold the paddles to your body when the defibrillator is on.
18. Clean the paddles and paddle storage areas after use. Even dried gel is a conductive pathway that could endanger the operator during a later use, and could impair paddle monitoring. Discard self-adhesive defibrillation electrodes after use.
19. Only gas sterilize internal paddles and cable sets. Periodically inspect all connections for evidence of corrosion or degradation. Replace sets which show signs of corrosion or degradation.
20. Periodically test the defibrillator. This will help to ensure that the defibrillator will be ready to use in an emergency. It will also help maintain operator familiarity. Press paddles firmly into the test load when discharging to prevent formation of pits. Such pits may increase the risk of patient burns. The frequency and extent of routine testing should be determined by institutional policy and practice.

PHYSIO CONTROL

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